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NASA CR 66625

Report No. 3001-11

COMPILATION OF ROCKET SPIN DATA

FINAL REPORT, VOLUME I
ACCELERATION TEST FACILITIES

FACILITY FORM 602

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EMERSON ELECTRIC REPORT NO. 3001-1

FINAL REPORT

COMPILATION OF ROCKET SPIN DATA

Volume I: ACCELERATION TEST FACILITIES

168-2842

By

Leo J. Manda, Emerson Electric Co.

Distribution of this report is provided in the interest of information exchange. Responsibility for the contents resides in the author or organization that prepared it.

Prepared under Contract No. NAS1-6833

for NASA Langley Research Center

15 June 1968

SECTION I

INTRODUCTION

For a number of years, the NASA and other Government agencies have been instrumental in developing solid propellant rocket motors which are spun to provide dynamic stability or reduce dispersion due to thrust misalignment. Prior to the use of metal additives in these propellants, no serious problems attributed to the spin environment had been encountered in vehicles of interest to the NASA, although definite spin sensitivity had been noted in a number of spin-stabilized tactical rocket motors. However, with the use of aluminum and other metal additives in the more recent propellant formulations, various motor performance anomalies have been experienced with motors subjected to even low spin rates.

Recognizing that a considerable amount of data pertinent to the effects of spin on solid propellant motor performance has been generated by Government agencies and contractors, the NASA Langley Research Center has contracted the Emerson Electric Co. to compile and evaluate this data in order to provide: (1) an improved base for dealing with the problems associated with motors operating in this environment; and (2) guidance for future research efforts in this area.

The results of this Compilation of Rocket Spin Data (CRSD) program are presented in this and two additional volumes of the CRSD final report. These volumes are organized according to:

- Volume I - Acceleration Test Facilities: describes the various spin and centrifuge test facilities available for testing solid propellant rocket motors in acceleration environments.
- Volume II - Literature Survey: summarizes the results of the extensive CRSD literature survey, documenting the acceleration effects experienced in various motor development programs and specifying the current state of the art in acceleration studies.
- Volume III - Data Evaluation and Recommendations: examines the test data obtained from the various Government agencies and contractors and recommends promising areas for future research activities.

This initial volume of the CRSD final report is divided into two primary areas of interest: (1) Spin Test Facilities; and (2) Centrifuge Test Facilities. The test facilities available for spinning motors of various size about their longitudinal axes at

rates up to 60,000 RPM are described in Section II. The centrifuge facilities, many of which provide for tests at different orientations of the acceleration vector with respect to the propellant surface, are described in Section III.

SECTION II

SPIN TEST FACILITIES

The capabilities of the twenty-five (25) spin test facilities described herein are summarized in Table II-1. As indicated, the majority (18) of these test fixtures employ either AC or DC electric motors to provide the driving power, with turbine-driven fixtures generally used for spin rate requirements in excess of 20,000 RPM.

Maximum spin test capabilities are summarized in Figure II-1, along with the appropriate designation of the various organizations providing the facilities which currently limit the spectrum of this test capability.

TABLE II-1: SPIN TEST FACILITIES

ORGANIZATION	DRIVING POWER	MAX. SPIN RATE (RPM)	MAX. MOTOR DIAMETER (IN)	MAX. MOTOR LENGTH (IN)	MAX. MOTOR MASS (LB _m)
Aerojet	Gas Turbine	30,000	10	14	160
	Electric	140	24	36	325
	Electric	300	22	40	500
AEDC	Electric	1,200	72	100	4,000
Atl. Res.	Air Turbine	45,000	4	8	10
	Electric	10,000	6	24	300
HPC (ABL)	Electric	400	20	30	300
NASA (LRC)	Electric	1,800	30	147	2,800
Lockheed	Self-Spun	1,000	8	10	25
NOTS (NWC)	Electric	18,000	5	18	75
	Electric	18,000	5	18	75
Picatinny A.	Electric	20,000	10	4	20
	Electric	16,000	6	20	60
	Electric	16,000	5	20	30
	Gas Turbine	25,000	2	6	5
Redstone A.	Air Turbine	45,000	2.5	7	60
	Self-Spun	40,000	7.5	21	180
	Electric	16,000	18	10	
	Electric	22,000	1.7	2.6	
Thiokol (E)	Air Turbine	60,000	3	10	10
	Electric	1,000	26	144	2,000
	Electric	400	37	192	4,000
	Electric	1,200	15	18	75
Thiokol (H)	Electric	16,000	9.5	25	150
UTC	Electric	3,500	6	14	

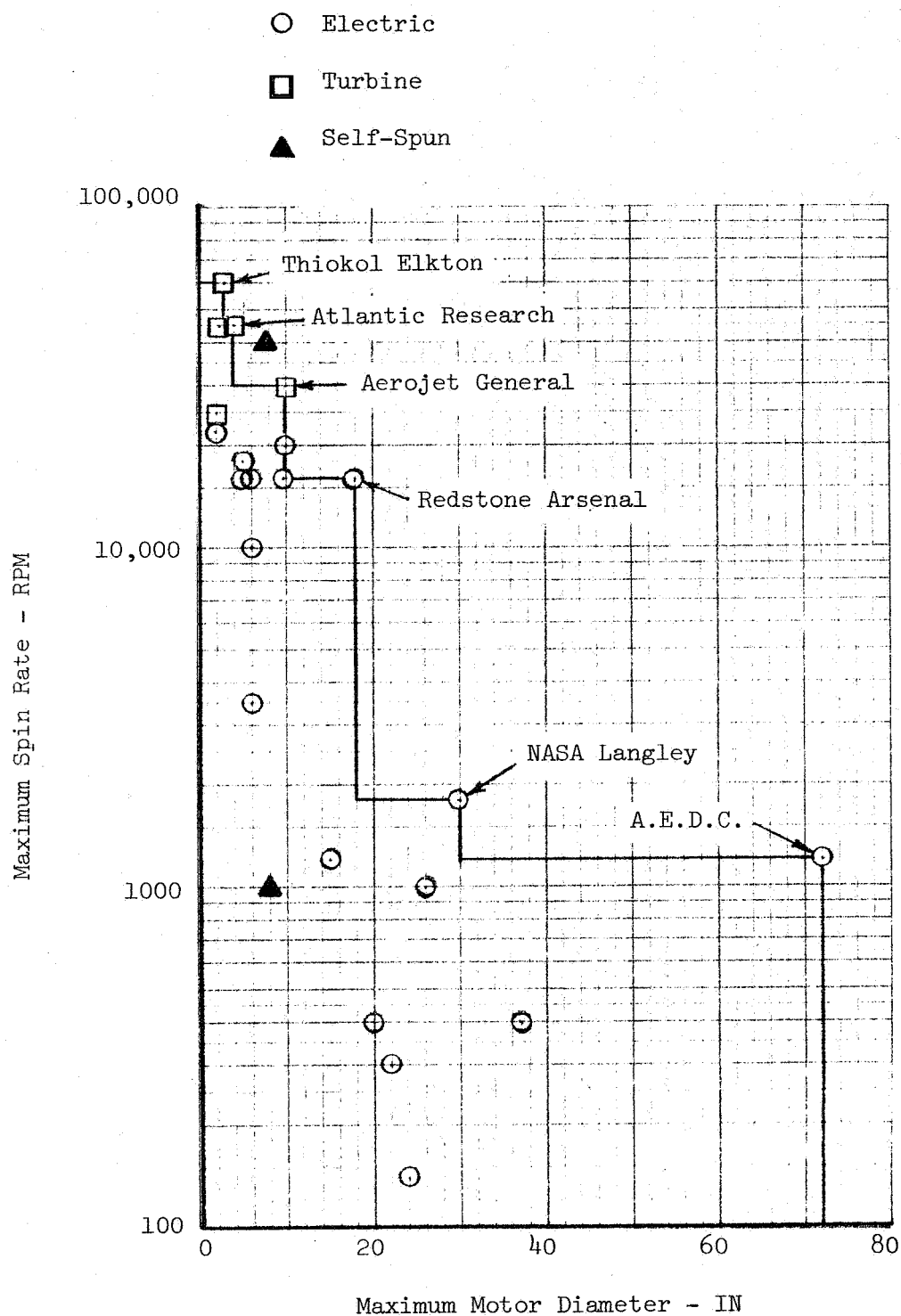


FIGURE 2 - 1: Spin Test Capabilities

SPIN TEST FACILITIES

Aerojet-General Corporation
P.O. Box 15847
Sacramento, California 95813

DESCRIPTION: Vertical-Firing Spin Test Fixture

Driven by a 35 HP gas turbine using nitrogen as the working fluid, this fixture is designed to provide pressure, thrust, and spin rate measurements at rotational speeds up to 30,000 RPM.

DIRECTOR: R. C. Poynter; Dept. 0761, Bldg. 0587; 916-355-6831

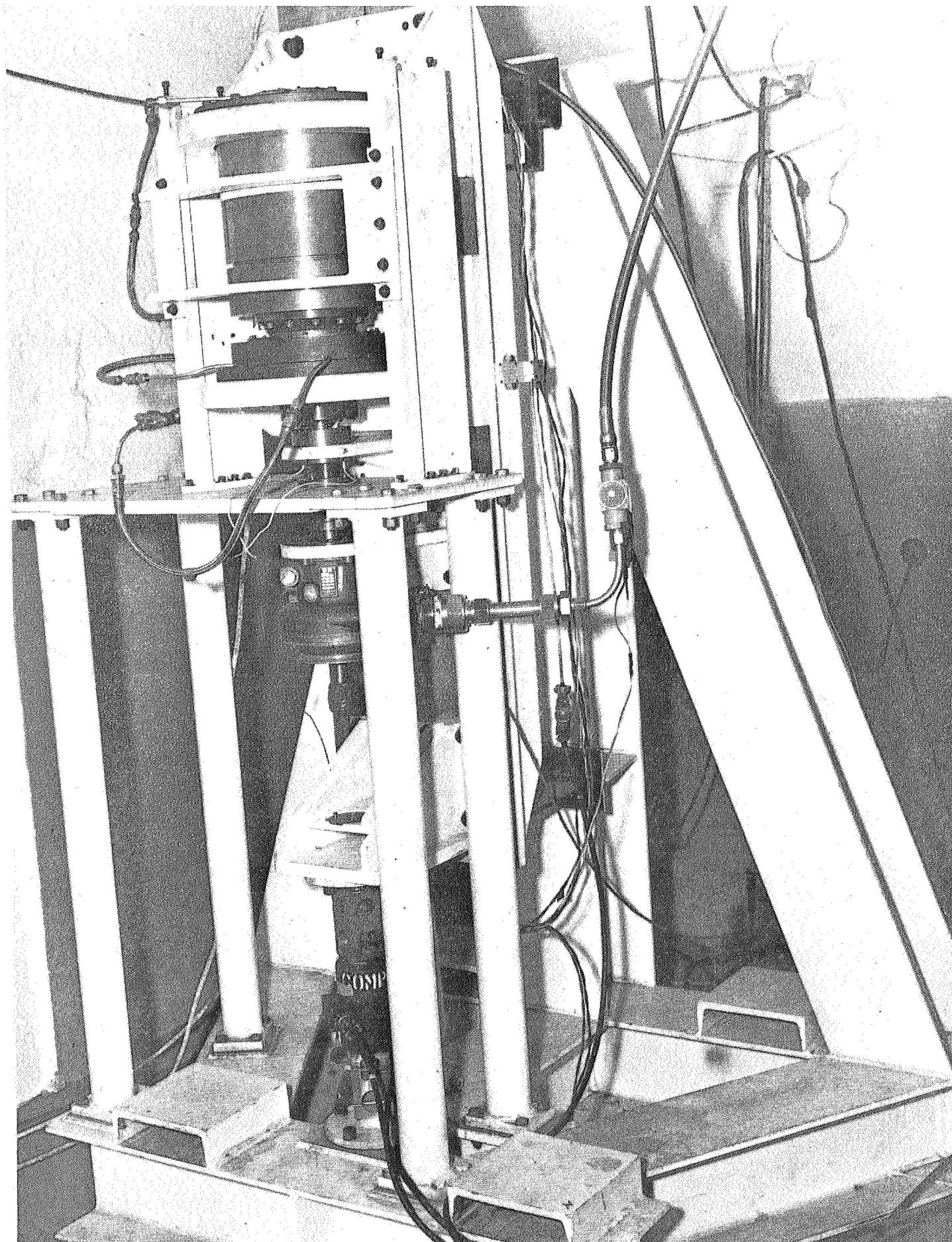
CAPABILITIES: Maximum spin rate: 30,000 RPM - (1)
Maximum motor diameter: 10.0 IN
Maximum motor length: 14.0 IN
Maximum motor mass: 160 LBm
Maximum thrust: 5000 LBf

DATA ACQUISITION: Pressure: 5000 psi (Pressure-Micro-Systems, Inc., Type MS-1) miniature semiconductor silicon strain element transducer, powered by a matched 28 volt D.C. driver. - (2)
Thrust: 5000 LBf (Baldwin-Lima-Hamilton (BLH), Type U3XXA) strain-gage load cell.
Spin Rate: (Clairex, Type CL604L) cadmium selenide photocell.
(Westport, Model 3030 AN) electromagnetic transducer.

DATA TRANSMISSION: (Lebow, Model 6120) 8-channel (gold) slip ring, 0-100,000 RPM.

ENVIRONMENTAL LIMITATIONS: -100°F to +350°F.

COMMENTS: (1) 18,000 RPM highest spin rate tested to date.
(2) Pressure data acquisition system not yet operational.



SPIN TEST FACILITIES

Aerojet-General Corporation
P.O. Box 15847
Sacramento, California 95813

DESCRIPTION: Horizontal-Firing Spin Test Fixture, P/N 1018461

Presently under construction, this fixture will be powered by a 3/4 HP electric motor through a gear drive. Pressure, thrust, roll rate, and temperature data will be provided at rotational speeds up to 140 RPM.

DIRECTOR: L. E. Stone; Dept. 0832, Bldg. 4610; 916-355-6867

CAPABILITIES: Maximum spin rate: 140 RPM
Maximum motor diameter: 24 IN
Maximum motor length: 36 IN
Maximum motor mass: 325 LBm
Maximum thrust: 10,000 LBf

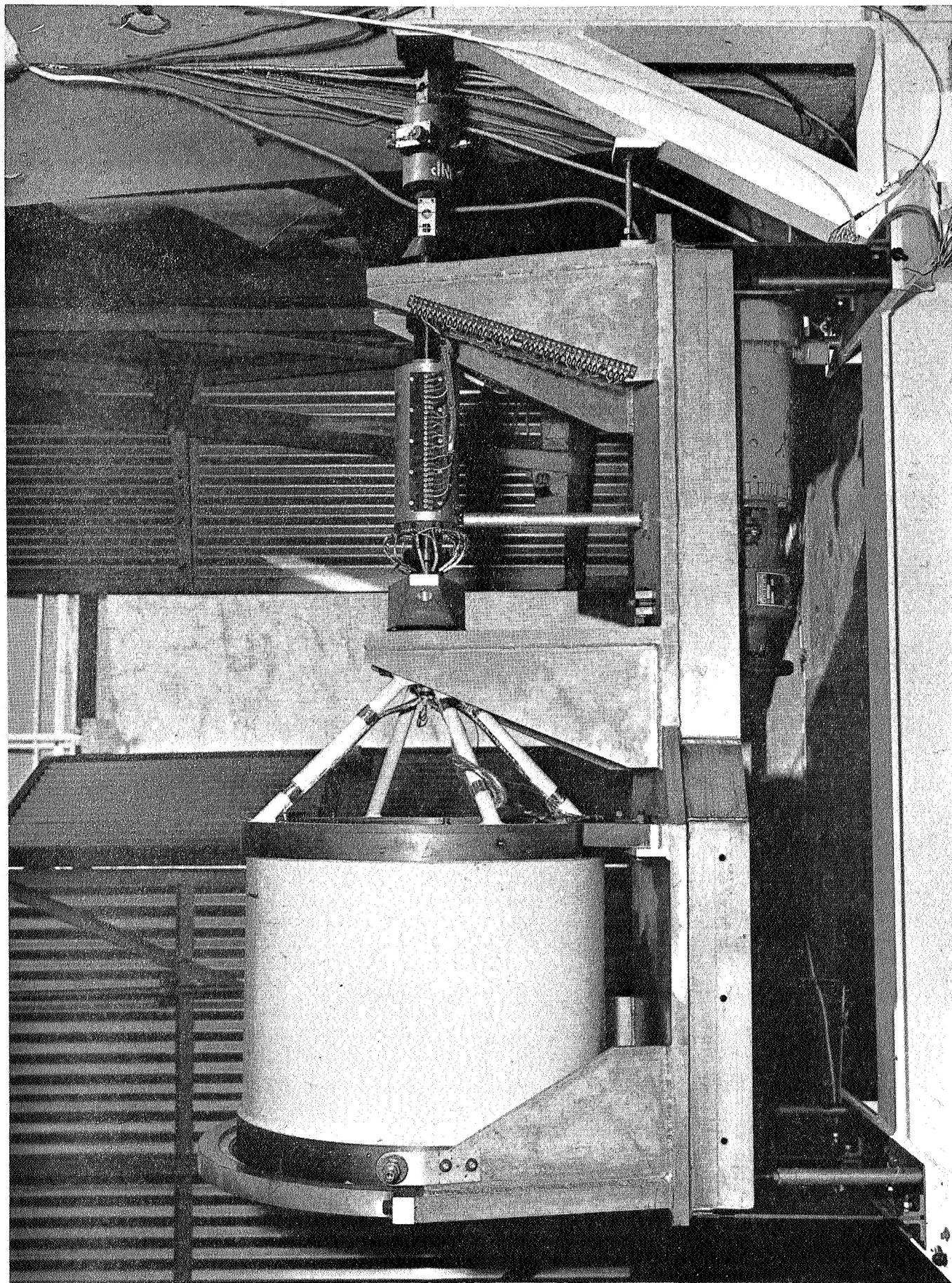
DATA ACQUISITION: Pressure: Two (Taber Transducers Inc., Model 206) pressure transducers. - (1)
Thrust: One (BLH, Model U3XXA) 5000 LBf load cell for in-place calibration; and one (BLH, Model U3XXA) 5000 LBf load cell for thrust measurement. - (2)
Spin Rate: (Electro Model 3010HT) electromagnetic proximity transducer.

DATA TRANSMISSION: (Fabricast Inc., Model Std. 1067 50 cct)
50-channel slip-ring, 0=1000 RPM.

PHYSICAL CHARACTERISTICS: Height: 53 IN
Base Area: 32 IN x 85 IN
Mass: 1200 LBm

ENVIRONMENTAL LIMITATIONS: Test Fixture: +30°F to +120°F;
Motor: -70°F to +300°F.

COMMENTS: (1) Chamber pressure measurement system uncertainty is $\pm 0.5\%$, 3σ . Temperature measurement system uncertainty is $\pm 3^\circ\text{F}$ or 1% , 3σ .
(2) In-place force measurement capability exists but not used to date. Force measurement system uncertainty estimated at $\pm 0.25\%$, 3σ . The motor/test fixture/force measurement system natural frequency is 35 Hz. The force signature is unaffected by spin environment.



SPIN TEST FACILITIES

Aerojet-General Corporation
P.O. Box 15847
Sacramento, California 95813

DESCRIPTION: Horizontal-Firing Spin Test Fixture, P/N 1015709

Powered by a 7.5 HP electric Varidrive motor through a belt drive, this fixture is designed to provide thrust, pressure, and spin rate data at rotational speeds up to 300 RPM.

DIRECTOR: L. E. Stone; Dept. 0832, Bldg. 5610; 916-355-6867.

CAPABILITIES: Maximum spin rate: 300 RPM
Maximum motor diameter: 22 IN
Maximum motor length: 40 IN
Maximum motor mass: 500 LBm
Maximum thrust: 30,000 LBf

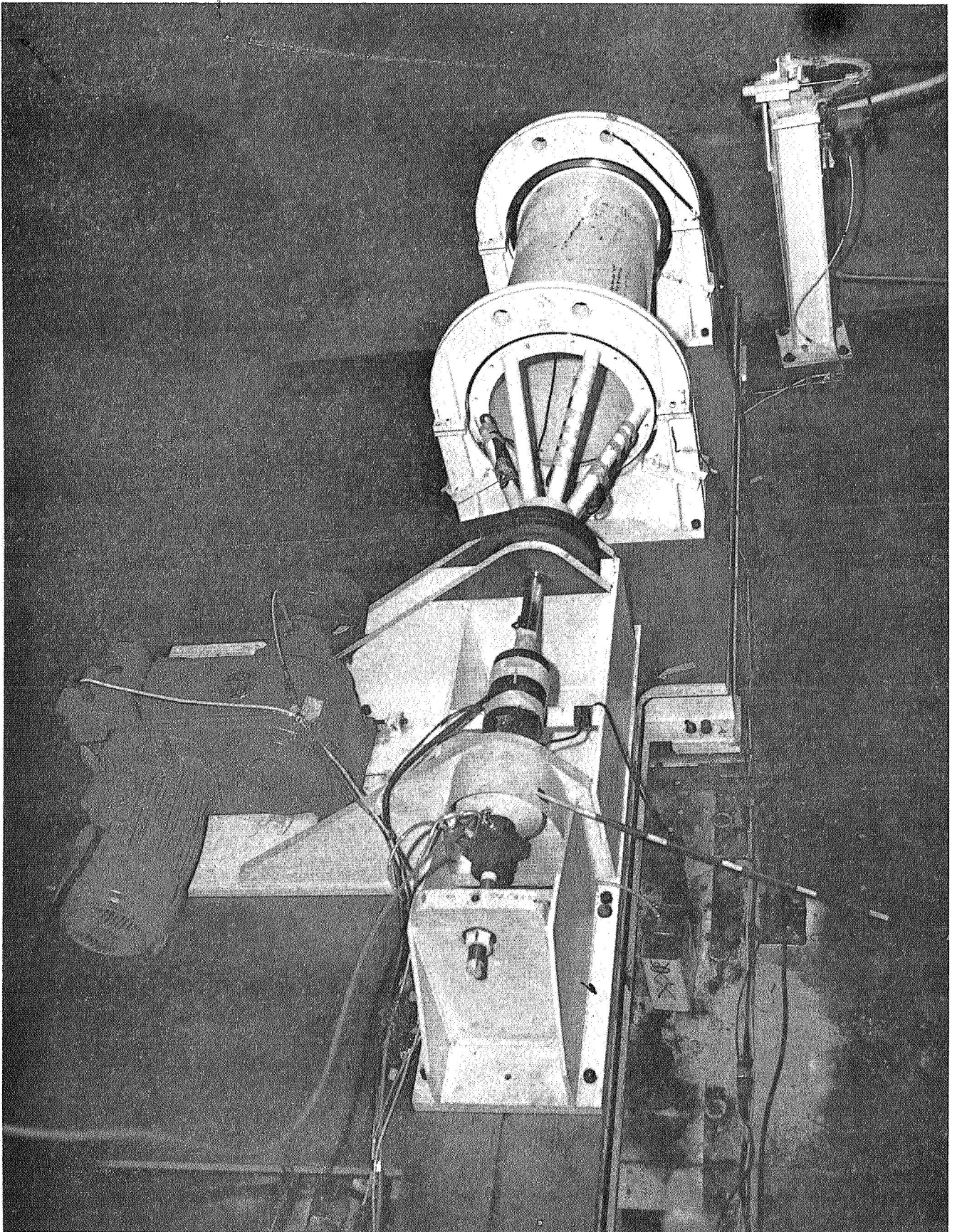
DATA ACQUISITION: Pressure: Typically 2 teed (Taber Transducer Inc., Model 206) pressure transducers
- (1)
Thrust: (BLH, Model U3XXA) 5000, 10,000 or 20,000 LBf load cells, as appropriate.
- (2)
Spin Rate: (Electro Model 3010HT) electromagnetic proximity transducer.

DATA TRANSMISSION: (Instrument Engineering Co., Model IECF 36-4)
36-channel slip ring.

PHYSICAL CHARACTERISTICS: Height: 44 IN
Base Area: 72 IN x 168 IN
Mass: 3900 LBm

ENVIRONMENTAL LIMITATIONS: Test Fixture: +30°F to +120°F;
Motor: -75°F to +300°F.

COMMENTS: (1) Chamber pressure measurement system uncertainty is $\pm 0.5\%$, 3σ . Temperature measurement system uncertainty is $\pm 3^\circ\text{F}$ or 1% , 3σ
(2) Force measurement system steady-state and impulse uncertainty estimated at $\pm 1.5\%$; 3σ . Transient and instantaneous force uncertainty estimated at $\pm 5.0\%$, 3σ . The motor/test fixture/force measurement system natural frequency is 75 Hz. A noise level of +100 LBf currently exists in the force measurement system as a result of imprecise alignment. However, this condition can be corrected.



SPIN TEST FACILITIES

Arnold Engineering Development Center
Air Force Systems Command
Rocket Test Facility
Arnold Air Force Station, Tenn, 37389

DESCRIPTION: Vacuum Spin Test Facility

This horizontal-firing spin test fixture is designed for use in the AEDC T-3 altitude test cell to allow spin testing at simulated altitudes up to 150,000 FT.

DIRECTOR: Capt. E. C. Westwood; AETR; 615-455-2611

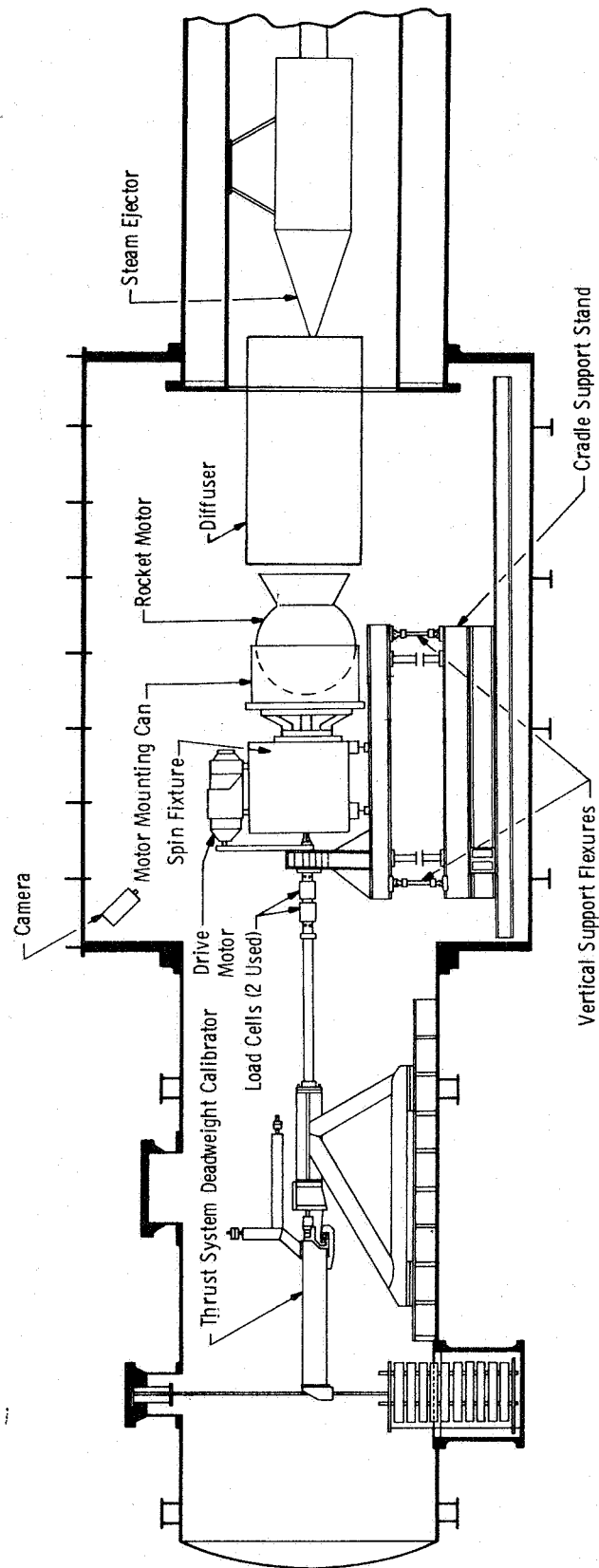
CAPABILITIES: Maximum spin rate: 1200 RPM - (1)
Maximum motor diameter: 37-72 IN - (2)
Maximum motor length: 100 IN - (3)
Maximum motor mass: 4000 LBm - (3)
Maximum thrust: 20,000 LBf

DATA ACQUISITION: Pressure: 2000 psi (Taber Instrumentation Corp., Model 226) strain-gage type pressure transducer.
Thrust: 20,000 LBf (BLH, Model C3P2) bonded strain-gage type load cell.
Spin Rate: 0-6000 Hertz (Electro Products Labs., Inc. Model 3030 HTB) electromagnetic transducer.

DATA TRANSMISSION: (Wendon Company Inc., Model W170-100)
150-channel slip ring, 0-1200 RPM.

ENVIRONMENTAL LIMITATIONS: +40°F to +90°F.

COMMENTS: (1) Spin fixture capabilities are determined by the combination of motor physical parameters. Contact the director with specific test requirements.
(2) Maximum motor diameter is limited to 37 IN for motors more than 4 FT in length.
(3) When the test article is cantilevered from the fixture mounting plate, the maximum allowable moment and shear are limited to 150,000 IN-LBf and 3000 LBf, respectively.



TYPICAL INSTALLATION OF ROCKET MOTOR IN PROPULSION ENGINE TEST CELL (T-3)

SPIN TEST FACILITIES

Atlantic Research Corporation
Shirley Highway at Edsall Road
Alexandria, Virginia 22314

DESCRIPTION: Air-Turbine Spin Test Stand

Driven by twin 4-IN air turbines, this portable test fixture provides pressure, thrust, and spin data at rotational speeds up to 45,000 RPM.

DIRECTOR: R. E. Wallace; Pine Ridge; 703-754-4111

CAPABILITIES: Maximum spin rate: 45,000 RPM
Maximum motor diameter: 4.0 IN
Maximum motor length: 8.0 IN
Maximum motor mass: 10.0 LBm
Maximum thrust: 500 LBf

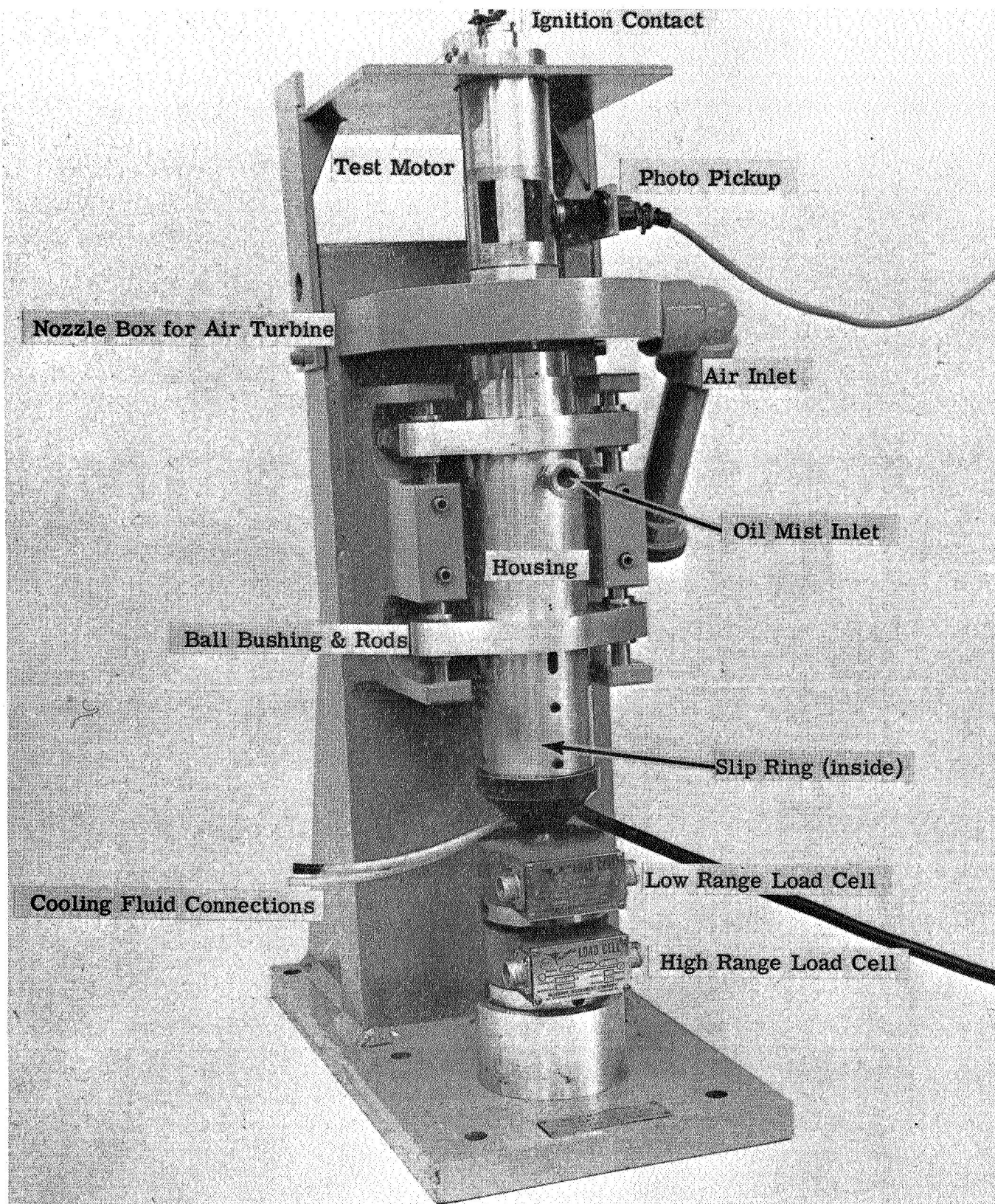
DATA ACQUISITION: Pressure: 5000 psi (Dynesco, Model PT 110) pressure transducer.
Thrust: Two (Alinco, Series 36) 500 LBf and 100 LBf load cells are mounted in series to provide greater accuracy over the test range.
Spin Rate: Electromagnetic transducer.

DATA TRANSMISSION: (Lebow, Mod 6120-8) 8-channel slip ring, cooled with Freon TF.

PHYSICAL CHARACTERISTICS: Height: 30 IN
Base Area: 9.5 IN x 18 IN
Mass: 100 LBm

ENVIRONMENTAL LIMITATIONS: -65°F to +200°F.

COMMENTS: The two 9 HP turbines exhaust up and down, respectively, to prevent any net thrust, regardless of air flow rate. To minimize the moving mass of the system, the turbine inlet nozzles are mounted on the stand support structure. Parallel air supplies are used to provide the three spin modes required: idle, for bearing lubrication and establishing dynamic baselines; acceleration, to test speed; and running, at test speed. Maximum test speed to date - 36,000 RPM.



AIR TURBINE THRUST STAND

SPIN TEST FACILITIES

Atlantic Research Corporation
Shirley Highway at Edsall Road
Alexandria, Virginia 22314

DESCRIPTION: 150mm Spin Test Stand

Powered by a 3 HP electric motor through a belt drive, this horizontal-firing fixture provides pressure, thrust, and spin rate measurements at rotational speeds up to 10,000 RPM.

DIRECTOR: R. E. Wallace; Pine Ridge; 703-754-4111

CAPABILITIES: Maximum spin rate: 10,000 RPM
Maximum motor diameter: 6 IN
Maximum motor length: 24 IN
Maximum motor mass: 300 LBm
Maximum thrust: 5000 LBf

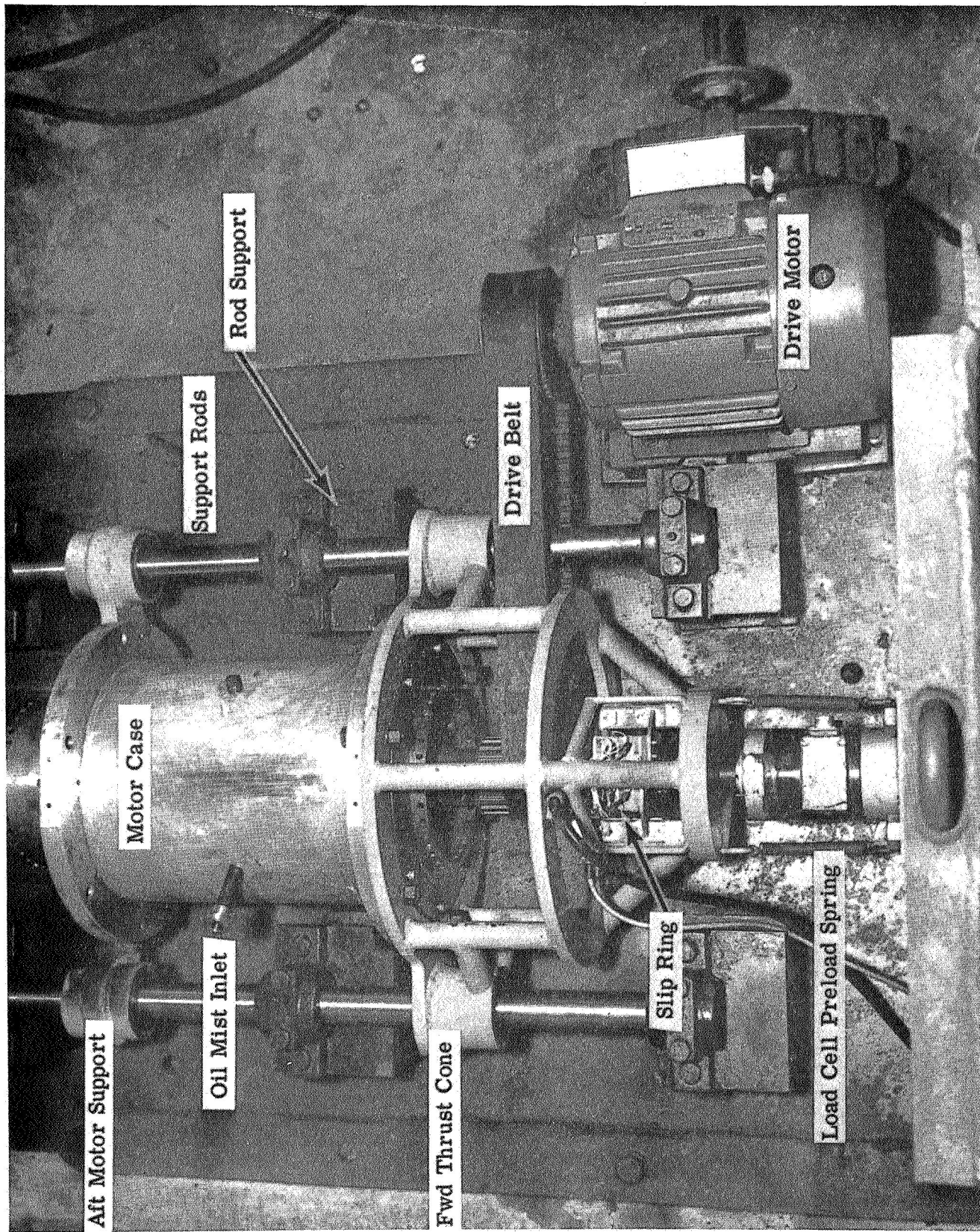
DATA ACQUISITION: Pressure: 5000 psi (Dynesco, Model PT 110) pressure transducer.
Thrust: (BLH, Model C3P2) 5000 LBf load cell.
Spin Rate: (Power Instruments Inc., Model B-836) photoelectric transducer.

DATA TRANSMISSION: (Breeze Corp., Model AJ 8003-A12) 12-channel slip ring.

PHYSICAL CHARACTERISTICS: Height: 18 IN
 Base Area: 36 IN x 60 IN
 Mass: 250 LBm

ENVIRONMENTAL LIMITATIONS: -65°F to +200°F.

COMMENTS: Housing, bearing, and rocket case are a single assembly in order to avoid the assembly and disassembly of precision mounting surfaces.



150 mm THRUST STAND

SPIN TEST FACILITIES

Hercules, Inc.
Allegany Ballistics Laboratory
P.O. Box 210
Cumberland, Maryland 21502

DESCRIPTION: Spin Test Stand

Driven by a 2 HP electric motor, this fixture can be used individually or mounted on the Hercules diesel-powered centrifuge to provide both axial and radial acceleration simultaneously.

DIRECTOR: R. S. Severyn; 304-726-4500

CAPABILITIES:

Maximum spin rate:	400 RPM
Maximum motor diameter:	20 IN
Maximum motor length:	30 IN
Maximum motor mass:	300 LBm
Maximum thrust:	10,000 LBf

SPIN TEST FACILITIES

National Aeronautics and Space Administration
Langley Research Center
Langley Station
Hampton, Virginia 23365

DESCRIPTION: Spin Test Fixture

Powered by a 10 HP synchronous electric motor through a timing belt drive, this fixture provides pressure, temperature, thrust, and spin rate measurements at rotational speeds up to 1800 RPM.

DIRECTOR: G. B. Northam; Mail Stop 498; 703-722-7961

CAPABILITIES: Maximum spin rate: 1800 RPM
Maximum motor diameter: 30 IN
Maximum motor length: 147 IN
Maximum motor mass: 2800 LBm
Maximum thrust: 20,000 LBf

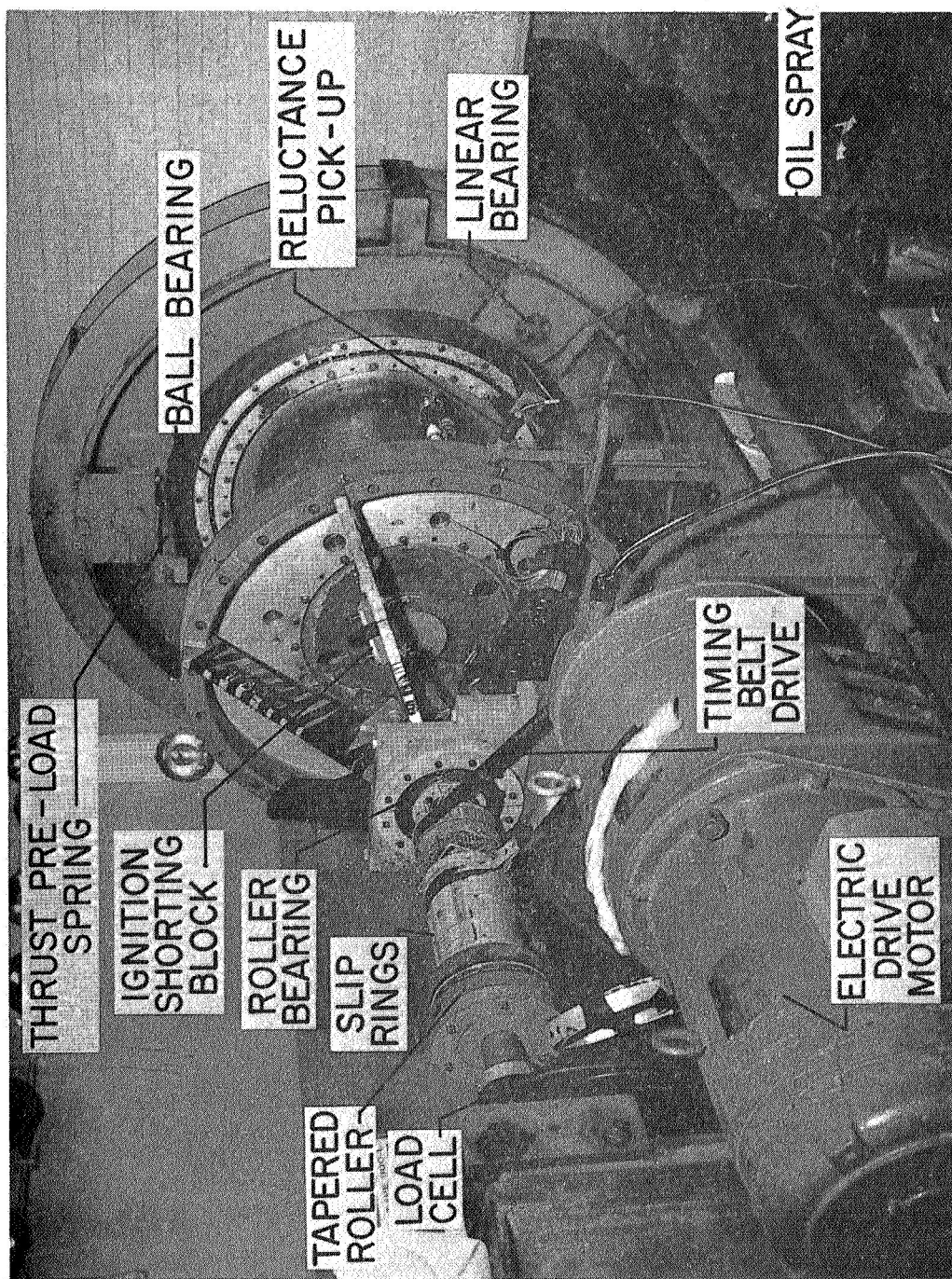
DATA ACQUISITION: Pressure: (Dynesco, Model PT121) strain-gage type pressure transducers.
Thrust: (BLH, Model U-1) load cell.
Spin Rate: (Elcor, Model 3040) reluctance type electromagnetic transducer.

DATA TRANSMISSION: (Wendon, Model W 36-100) 36-channel slip ring.

PHYSICAL CHARACTERISTICS: Height: 60 IN
Base Area: 60 IN x 200 IN
Mass: 1500 LBm

ENVIRONMENTAL LIMITATIONS: 0°F to 110°F.

COMMENTS: This test fixture is more fully described by M. H. Lucy, R. L. Swain, and P. H. Foss in: "Rocket Motor Spin Test Apparatus"; presented at the Second Annual Meeting of the ICRPG Working Group on Static Testing; Redlands, California; 21 October 1964.



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SPIN TEST FACILITIES

Lockheed Propulsion Co.
P.O. Box 111
Redlands, California

DESCRIPTION: Spin/Torque Test Fixtures

These test fixtures for small rocket motors are designed to measure either spin torque or spin rate (self-induced by canted nozzles). Simulated altitude testing is accomplished in a 1300 cu. FT vacuum tank.

DIRECTOR: W. D. Poling; Dept. 7300; 714-793-2211, Ext. 3510

CAPABILITIES: Maximum spin rate: 1000 RPM
Maximum motor diameter: 8 IN
Maximum motor length: 10 IN
Maximum motor mass: 25 LBm
Maximum thrust: 2500 LBf

DATA ACQUISITION: Pressure: (Transducers, Inc.) miniature bonded strain-gage pressure transducer.
Thrust: (Schaevitz/By-Trex) solid-state load cells.

DATA TRANSMISSION: Slip ring.

PHYSICAL CHARACTERISTICS: Height: 18 IN
Base Area: 18 IN x 18 IN
Mass: 200 LBm

ENVIRONMENTAL LIMITATIONS: 0°F to +120°F.

SPIN TEST FACILITIES

U.S. Naval Weapons Center
(Naval Ordnance Test Station)
China Lake, California 93555

DESCRIPTION: Horizontal-Firing Spin Test Fixture

Powered by a 15 HP 220-volt AC motor through a belt drive, this fixture provides thrust, pressure, temperature, and spin rate measurements at rotational speeds up to 18,000 RPM.
(1)

DIRECTOR: Roy B. Johanboeke; Code 4531; 714-375-4111
(Ext. 9381)

CAPABILITIES: Maximum spin rate: 18,000 RPM-(2)
Maximum motor diameter: 5.0 IN
Maximum motor length: 12-18 IN
Maximum motor mass: 75 LBm
Maximum thrust: 1000 LBf

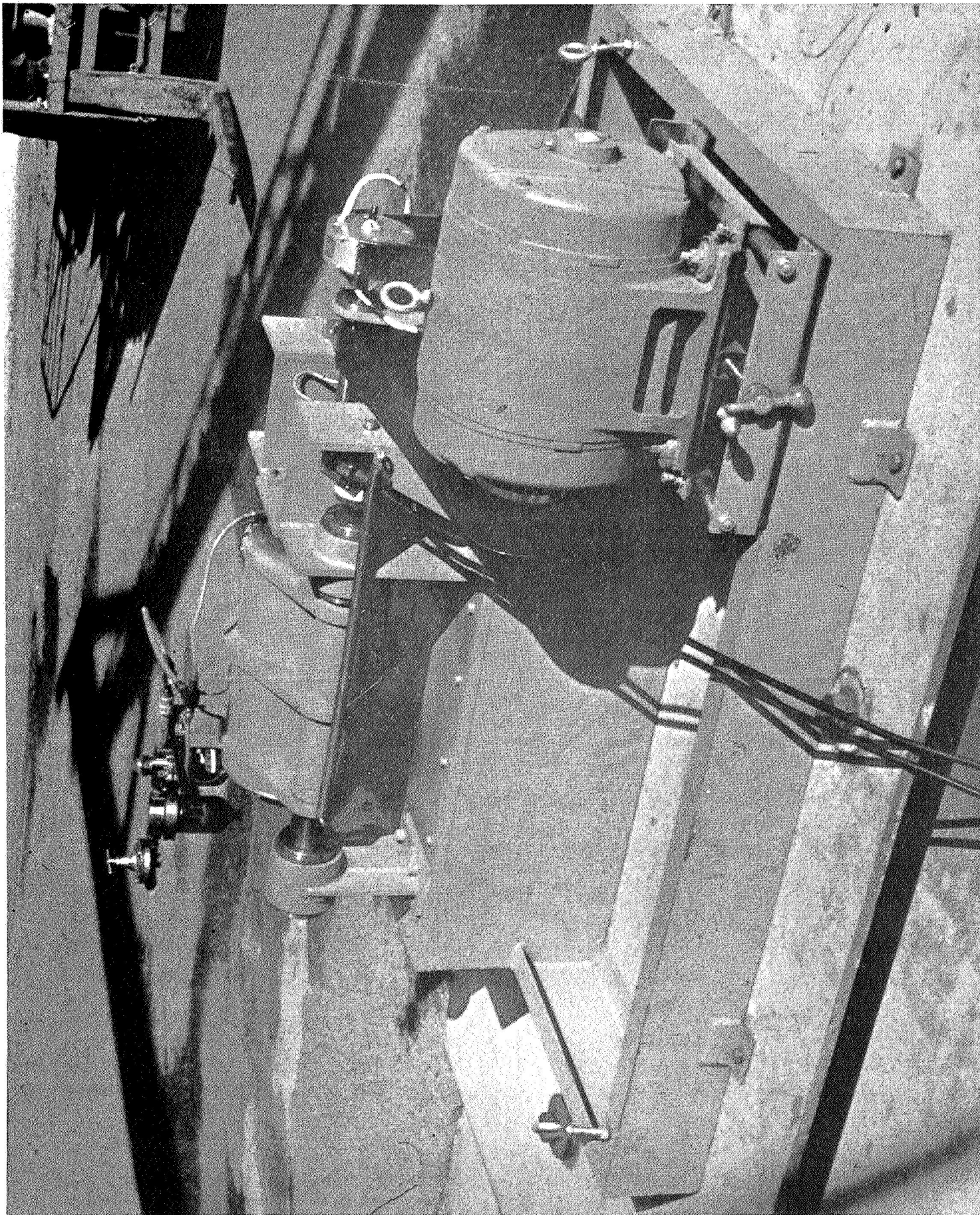
DATA ACQUISITION: Pressure: 3000 psi (CEC, Model 4-313) unbounded strain-gage transducer.
Thrust: Two 500 LBf (Toroid Co., Model 35-133-DTH) strain-gage load cells.
Spin Rate: (Airpax Electronics, Model 340-0001) electromagnetic transducer.

DATA TRANSMISSION: (Breeze Corp., Model AJ-10203) 6-channel slip ring.

PHYSICAL CHARACTERISTICS: Height: 25 IN
Base Area: 42 IN x 62 IN
Mass: 1000 LBm

ENVIRONMENTAL LIMITATIONS: +35°F to +115°F.

COMMENTS: (1) This fixture design is adapted from an original design by Picatinny Arsenal.
(2) Test spin rate is determined by appropriate pulley size.



SPIN TEST FACILITIES

U.S. Naval Weapons Center
(Naval Ordnance Test Station)
China Lake, California 93555

DESCRIPTION: Vertical-Firing Spin Test Fixtures

Powered by a 4 HP 28-volt DC motor, this fixture provides thrust and spin rate measurements at rotational speeds up to 18,000 RPM. Eight (8) of these fixtures are available.

DIRECTOR: Roy B. Johanboeke; Code 4531; 714-375-1411 (Ext. 9381)

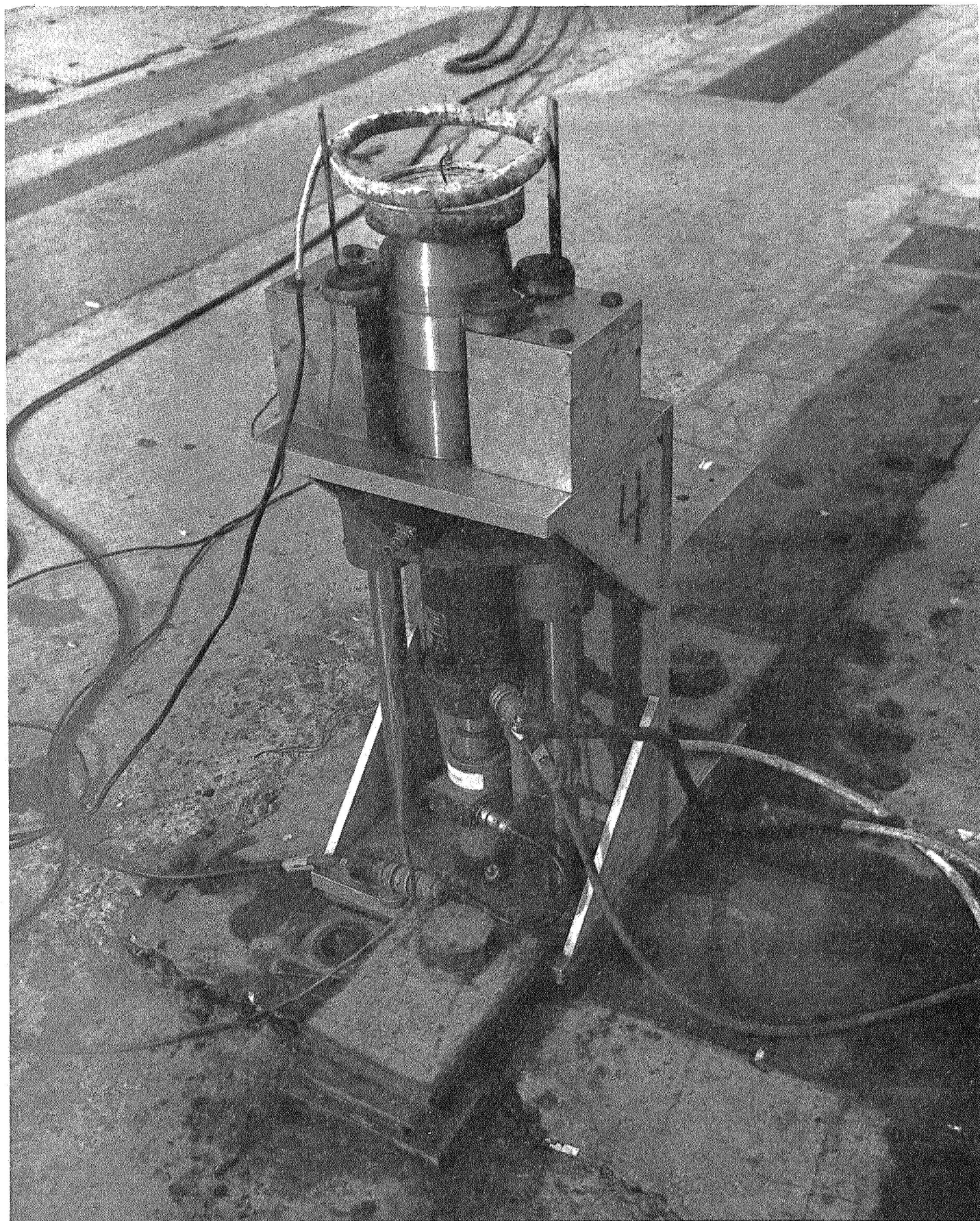
CAPABILITIES: Maximum spin rate: 18,000 RPM
Maximum motor diameter: 5 IN
Maximum motor length: 18 IN
Maximum motor mass: 75 LBm
Maximum thrust: 1200 LBf

DATA ACQUISITION: Pressure: None. - (1)
Thrust: 2000 LBf (Toroid Co., Model 35133DTH)
strain-gage load cell.
Spin Rate: -(Power Instruments Inc., Model
C-836 photoelectric transducer with
Model 835 power supply.
-(Airpax Electronics, Model 340-0001)
electromagnetic transducer.

PHYSICAL CHARACTERISTICS: Height: 27 - 39 IN-(2)
Base Area: 14 IN x 19 IN
Mass: 125 LBm

ENVIRONMENTAL LIMITATIONS: +35°F to +115°F. - (3)

COMMENTS: (1) A modified version of this fixture has been built to provide chamber pressure data, but has not been used extensively.
(2) Height variable to accommodate x-ray movie coverage.
(3) These temperature limits represent the total range of operating conditions to date.



SPIN TEST FACILITIES

Picatinny Arsenal
Dover, New Jersey 07801

DESCRIPTION: Component Spin Test Fixture

Powered by a 30 HP AC motor through a belt drive, this fixture is designed to investigate the structural integrity of various missile components by obtaining strain measurements.

DIRECTOR: F. C. Femia; T.S.L. Bldg. 1501; 201-328-3427

CAPABILITIES: Maximum spin rate: 20,000 RPM
Maximum motor diameter: 10.0 IN
Maximum motor length: 4.0 IN
Maximum motor mass: 20 LBm
Maximum thrust: 0 LBf

DATA ACQUISITION: Pressure: None provided.
Thrust: None provided.
Spin Rate: (Electro Products, Model 3015A) electromagnetic transducer.

DATA TRANSMISSION: (Breeze Corp., Model AJ 11744) 6-channel coin silver slip ring; 0-20,000 RPM.

ENVIRONMENTAL LIMITATIONS: -100°F to +200°F.

COMMENTS: This fixture is presently being installed.

SPIN TEST FACILITIES

Picatinny Arsenal
Dover, New Jersey 07801

DESCRIPTION: Horizontal-Firing Spin Test Fixture

Driven by a 25 HP AC motor through a belt drive, this fixture provides pressure, thrust, and spin rate measurements at speeds up to 16,000 RPM.-(1)

DIRECTOR: F. C. Femia; T.S.L. Bldg. 1501; 201-328-3427

CAPABILITIES: Maximum spin rate: 16,000 RPM
Maximum motor diameter: 6.0 IN
Maximum motor length: 20.0 IN
Maximum motor mass: 60.0 LBm
Maximum thrust: 5000 LBf

DATA ACQUISITION: Pressure: 5000 psi (Picatinny-fabricated)
strain gage pressure transducer.
Thrust: 5000 LBf (BLH) strain-gage load
cell.
Spin Rate: (Electro Products, Model 3015A)
electromagnetic transducer.

DATA TRANSMISSION: (Breeze Corp., Model AJ 11744) 6-channel
coin silver slip ring.

ENVIRONMENTAL LIMITATIONS: -100°F to +200°F.

COMMENTS: (1) An x-ray movie system is to be incorporated with
this fixture, but is not yet operational.

SPIN TEST FACILITIES

Picatinny Arsenal
Dover, New Jersey 07801

DESCRIPTION: Horizontal - Firing Spin Test Fixtures

Powered by 20 HP DC electric motors through belt drives, these (2) test fixtures are designed to provide pressure, thrust, and spin rate measurements at rotational speeds up to 16,000 RPM.
- (1), - (2).

DIRECTOR: F. C. Femia; T.S.L. Bldg. 1501; 201-328-3427

CAPABILITIES: Maximum spin rate: 16,000 RPM
Maximum motor diameter: 5.0 IN
Maximum motor length: 20.0 IN
Maximum motor mass: 30 LBm
Maximum thrust: 5000 LBf

DATA ACQUISITION: Pressure: 5000 psi (Picatinny-fabricated) strain-gage pressure transducer.
Thrust: 5000 LBf (BLH) strain-gage load cell.
Spin Rate: (Electro Products, Model 3015A) electromagnetic transducer.

DATA TRANSMISSION: (Breeze Corp., Model AJ11744) 6-channel coin silver slip ring; 0-20,000 RPM.

ENVIRONMENTAL LIMITATIONS: -100°F to +200°F.

COMMENTS: (1) These fixtures are used primarily for testing the 40, 105, 107, and 155mm rocket-assisted projectile (RAP) motors.
(2) Both fixtures provide for interrupted burning under spin.

SPIN TEST FACILITIES

Picatinny Arsenal
Dover, New Jersey 07801

DESCRIPTION: Turbine-Driven Spin Test Fixture

Driven by a gas turbine using nitrogen as the working fluid, this horizontal-firing fixture is designed to provide thrust and spin rate measurements at rotational speeds up to 25,000 RPM.

DIRECTOR: F. C. Femia; T.S.L. Bldg. 1501; 201-328-3427

CAPABILITIES: Maximum spin rate: 25,000 RPM
Maximum motor diameter: 2.0 IN
Maximum motor length: 6.0 IN
Maximum motor mass: 5.0 LBm
Maximum thrust: 500 LBf

DATA ACQUISITION: Pressure: None provided.
Thrust: 5000 LBf (BLH) strain-gage load cell.
Spin Rate: (Electro Products, Model 3015A) electromagnetic transducer.

ENVIRONMENTAL LIMITATIONS: -100°F to +200°F.

SPIN TEST FACILITIES

U.S. Army Missile Command
Propulsion Laboratory
Redstone Arsenal
Huntsville, Alabama 35809

DESCRIPTION: Air-Turbine Spin Test Strand

Powered by an air turbine, this fixture provides pressure, thrust, and spin rate measurements at rotational speeds up to 45,000 RPM.

DIRECTOR: N. G. Blood; AMSMI-RKF; 205-876-0341

CAPABILITIES: Maximum spin rate: 45,000 RPM
Maximum motor diameter: 2.5 IN
Maximum motor length: 7.0 IN
Maximum thrust: 500 LBf

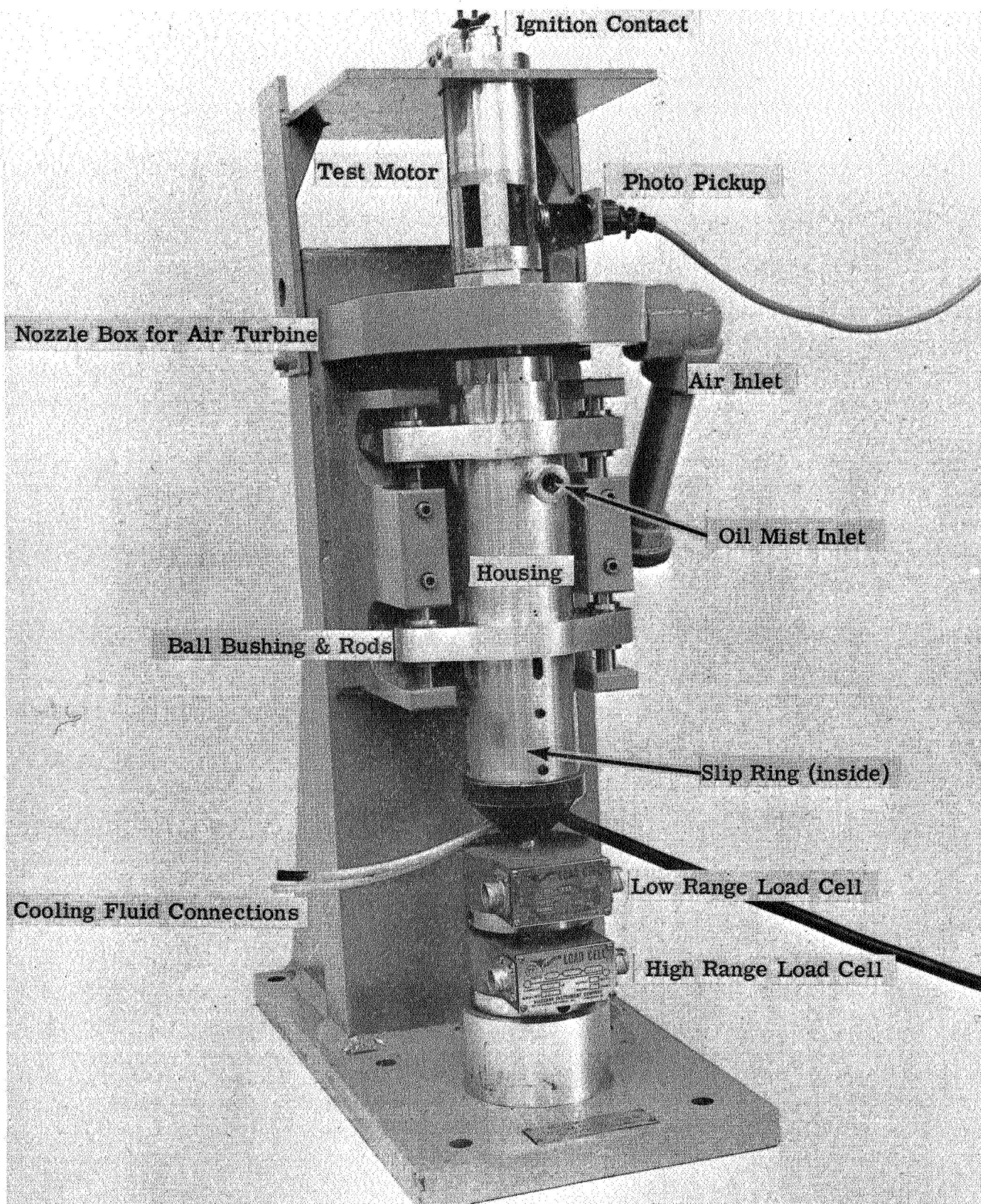
DATA ACQUISITION: Pressure: 3000 psi (Dynesco, Model PT 1110-3M)
pressure transducer.
Thrust: Two (Alnico, Model 36-233-BAA) 300 LBf
load cells, mounted in series.
Spin Rate: (Power Instruments Inc., Model B-836)
transistorized photoelectric transducer.

DATA TRANSMISSION: (Lebow, Model 6120-8) 8-channel slip ring cooled
with Freon TF.

PHYSICAL CHARACTERISTICS: Height: 30 IN
Base Area: 10 IN x 18 IN
Mass: 300 LBm

ENVIRONMENTAL LIMITATIONS: -65°F to +160°F (Propellant).

COMMENTS: Test fixture performance is entirely automatic. Closing the "start" switch initiates the oil mist lubrication system and "idling" air supply. After an 0.5 sec. delay to insure complete lubrication, a time-delay relay circuit opens the solenoid-actuated "accelerating" air supply. The photo pickup continuously monitors spin rate to a frequency meter. At the pre-selected test spin rate, the frequency meter triggers a mechanism which simultaneously: (1) shuts off the "accelerating air supply; (2) opens a third solenoid valve to admit a supply of air sufficient to maintain rotational speed; and (3) fires the motor.



SPIN TEST FACILITIES

U. S. Army Missile Command
Propulsion Laboratory
Redstone Arsenal
Huntsville, Alabama 35809

DESCRIPTION: Horizontal Spin Test Fixture

Powered by a 5 HP variable-speed D. C. Motor through a belt drive, this fixture provides pressure, thrust, and spin rate measurements at rotational speeds up to 16,000 RPM.

DIRECTOR: N. G. Flood; AMSMI-RKE; 205-876-0341

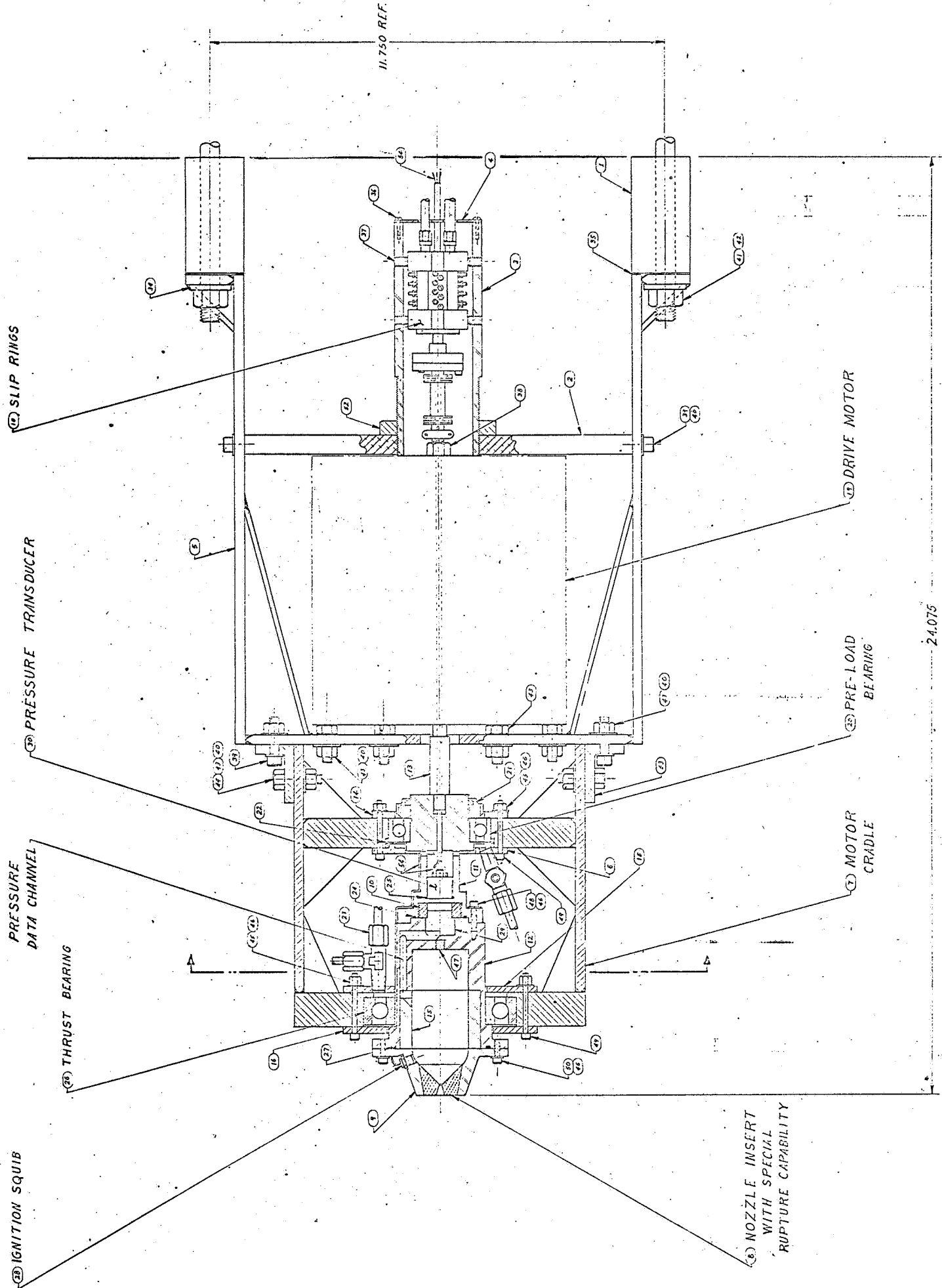
CAPABILITIES: Maximum spin rate: 16,000 RPM
Maximum motor diameter: 18 IN
Maximum motor length: 10 IN
Maximum motor mass: 180 LBm (propellant)
Maximum thrust: 500 LBf

DATA ACQUISITION: Pressure: 1500 psi (CEC Model 4-313-001 pressure transducer.
Thrust: 500 LBf (BLH, Model #U-1 TXX) dual-bridge load cell.
Spin Rate: Electromagnetic transducer.

DATA TRANSMISSION: (Lebow) 8-channel slip ring, 0-12,000 RPM.

PHYSICAL CHARACTERISTICS: Height: 41 IN
Base Area: 63 IN x 40 IN

ENVIRONMENTAL LIMITATIONS: -65°F to +160°F (propellant).



SPIN TEST FACILITIES

U. S. Army Missile Command
Propulsion Laboratory
Redstone Arsenal
Huntsville, Alabama 35809

DESCRIPTION: Self-Induced Spin Test Stand

Constructed to provide for spin tests of motors with self-contained spin-up capabilities, this vertical-firing fixture provides pressure, thrust, and spin rate measurements at rotational speeds up to 40,000 RPM.

DIRECTOR: N. G. Flood; AMSMK-RKF; 205-876-0341

CAPABILITIES: Maximum spin rate: 40,000 RPM - (1)
Maximum motor diameter: 7.5 IN
Maximum motor length: 21.0 IN
Maximum motor mass: 60 LBm
Maximum thrust: 7000 LBf

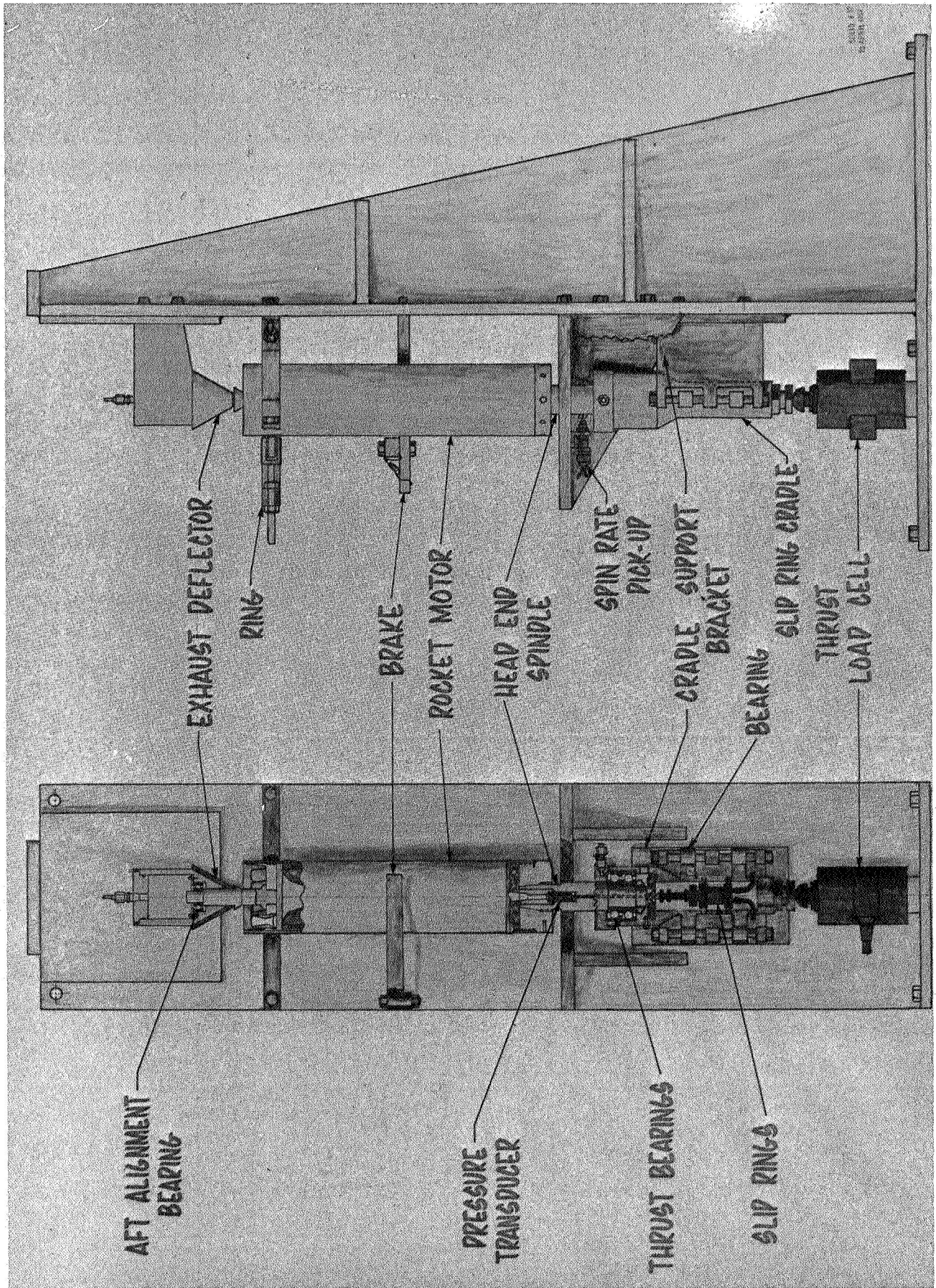
DATA ACQUISITION: Pressure: 5000 psi (CEC, Model 4-313)
strain-gage pressure transducer.
Thrust: 5000 LBf (BLH, Model #U-1 TXX)
dual-bridge load cell.
Spin Rate: (Electro, Model 3040-A) electro-
magnetic transducer.

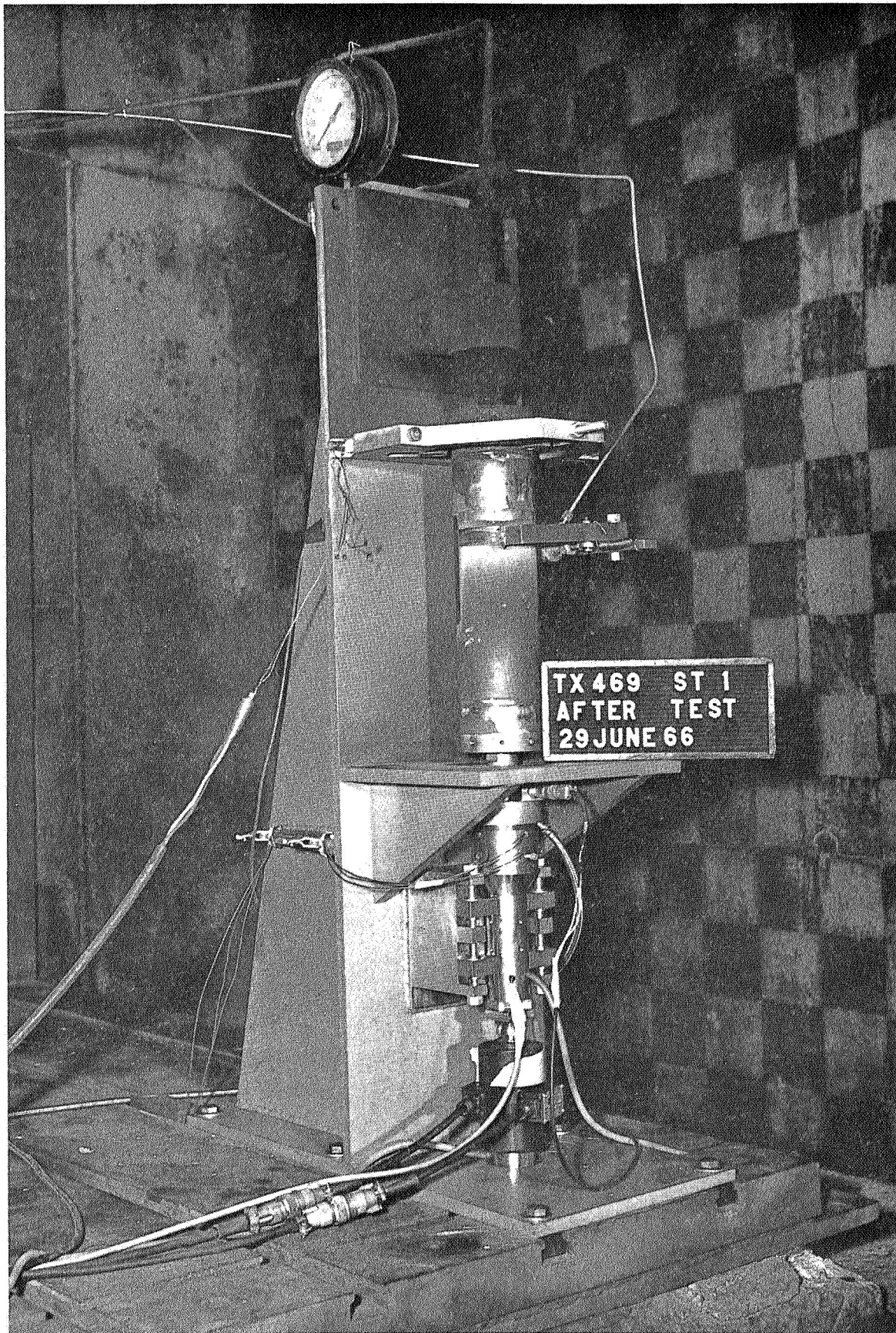
DATA TRANSMISSION: (Lebow, Model 6120-8) 8-channel slip ring
cooled with Freon TF, 0-100,000 RPM.

PHYSICAL CHARACTERISTICS: Height: 56 IN
Base Area: 14 IN x 33 IN
Mass: 650 LBm

ENVIRONMENTAL LIMITATIONS: -65°F to +160°F (Propellant).

COMMENTS: (1) 38,000 RPM highest spin rate tested to date.





SPIN TEST FACILITIES

U. S. Army Missile Command
Propulsion Laboratory
Redstone Arsenal
Huntsville, Alabama 35809

DESCRIPTION: Electrically Driven Spin Test Fixture

Powered by a 5 HP direct-drive DC motor, this vertical-firing fixture provides pressure and spin rate measurements at rotational speeds up to 22,000 RPM.

DIRECTOR: W. L. Strickland; AMSMI-RKM; 205-876-2516

CAPABILITIES: Maximum spin rate: 22,000 RPM
Maximum motor diameter: 1.67 IN - (1)
Maximum motor length: 2.55 IN - (1)
Maximum motor mass: .346 LBm (Propellant)
Maximum pressure: 2000 psi

DATA ACQUISITION: Pressure: 5000 psi (CEC, Model 4-311) strain-gage pressure transducer.
Thrust: None provided.
Spin Rate: Photoelectric transducer with a (Berkley, Model 7370) counter.

DATA TRANSMISSION: (Lebow, Model 6120-8) 8-channel slip ring cooled with Freon TF, 0-100,000 RPM.

PHYSICAL CHARACTERISTICS: Height: 24.0 IN
Base Area: 13 IN x 7 IN
Mass: 50 LBm

ENVIRONMENTAL LIMITATIONS: -40°F to +140°F

COMMENTS: (1) A heavywall motor chamber is provided as an integral component of the test stand. Only the grain and nozzle sizes are variable.

SPIN TEST FACILITIES

Thiokol Chemical Corporation
Elkton Division
Elkton, Maryland 21921

DESCRIPTION: 3-IN Horizontal Spin Test Fixture

Powered by an air turbine, this horizontal-firing fixture provides for thrust and spin rate measurements at rotational speeds up to 60,000 RPM.

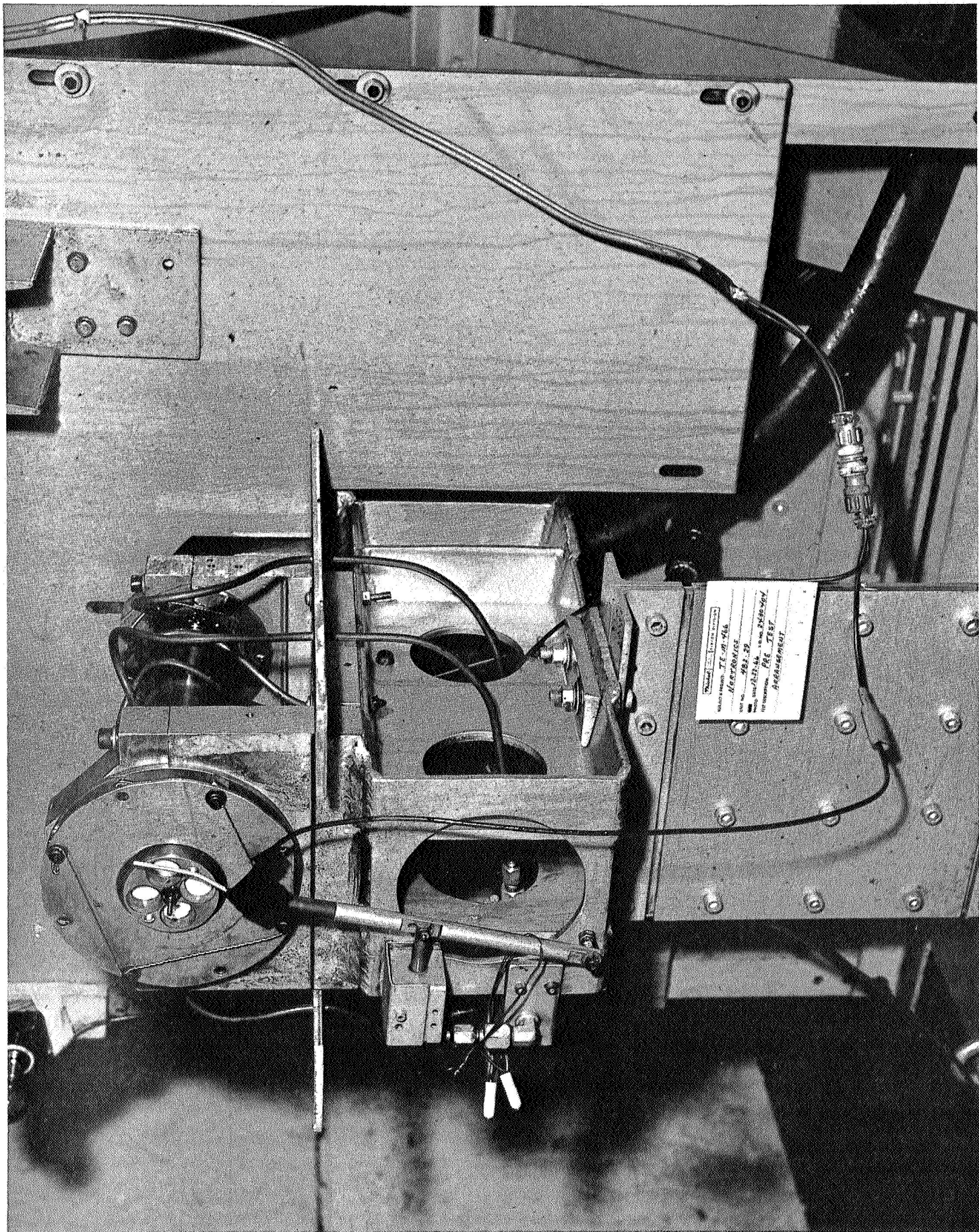
DIRECTOR: D. H. Williamson; 301-398-3000 (Ext. 307)

CAPABILITIES: Maximum spin rate: 60,000 RPM
Maximum motor diameter: 3 IN
Maximum motor length: 10 IN
Maximum motor mass: 10 LBm
Maximum thrust: 5,000 LBf

DATA ACQUISITION: Pressure: None provided. Could be modified to incorporate 2 pressure transducers.
Thrust: 2 load cells.
Spin Rate: Electromagnetic transducers.

PHYSICAL CHARACTERISTICS: Height: 48 IN
Base Area: 36 IN x 48 IN
Mass: 600 LBm

ENVIRONMENTAL LIMITATIONS: -90° to +300°F.



SPIN TEST FACILITIES

Thiokol Chemical Corporation
Elkton Division
Elkton, Maryland 21921

DESCRIPTION: 26-IN Horizontal Spin Test Fixture

Powered by a 10 HP electric motor through pulleys, this horizontal-firing fixture provides pressure, thrust, and spin rate measurements at rotational speeds up to 1200 RPM.

DIRECTOR: D. H. Williamson; 301-398-3000, (Ext. 307)

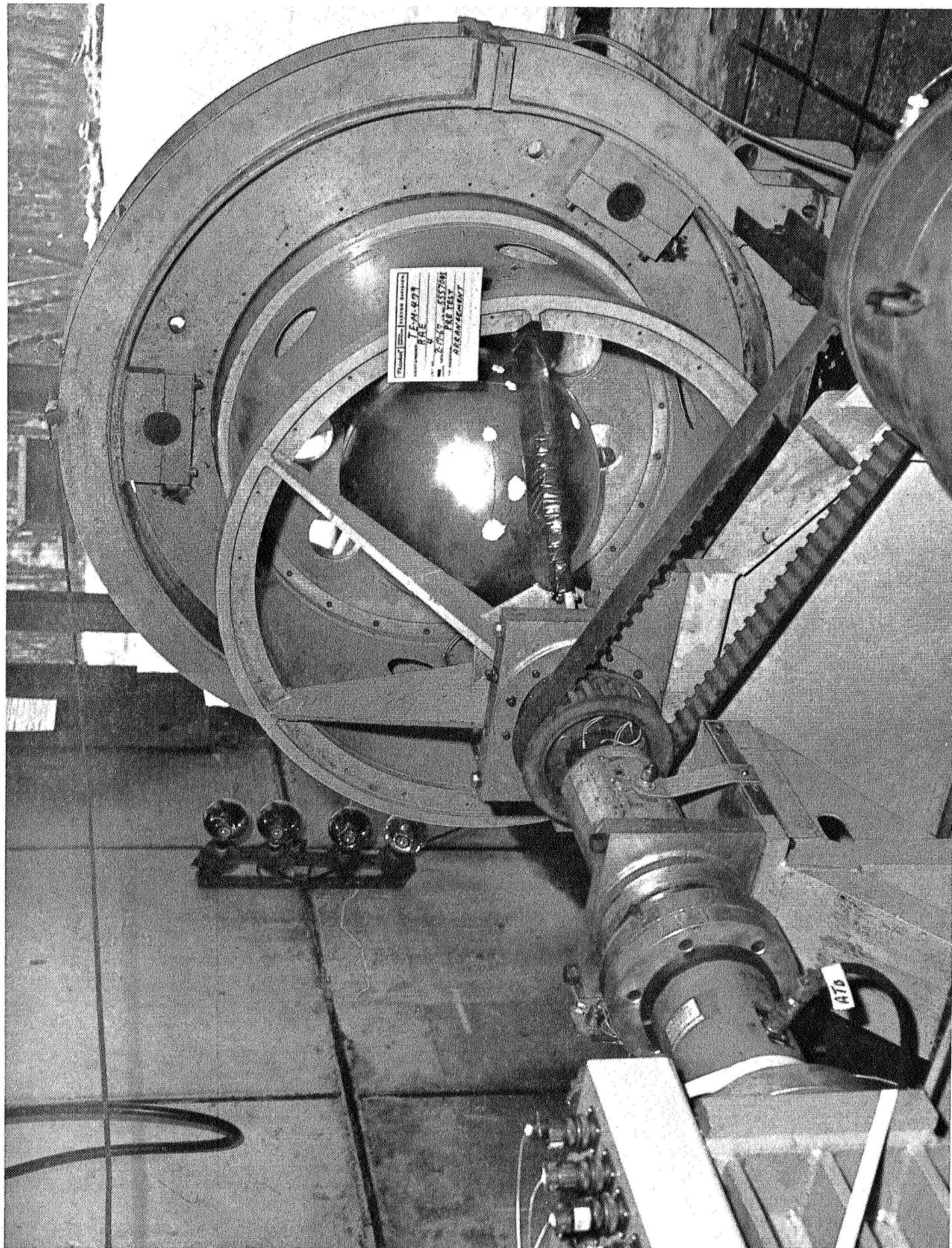
CAPABILITIES: Maximum spin rate: 1200 RPM
Maximum motor diameter: 26 IN
Maximum motor length: 144 IN
Maximum motor mass: 2000 LBm
Maximum thrust: 10,000 LBf

DATA ACQUISITION: Pressure: 4 pressure transducers.
Thrust: 2 load cells.
Spin Rate: electromagnetic transducer.

DATA TRANSMISSION: 36-channel slip ring.

PHYSICAL CHARACTERISTICS: Height: 72 IN
Base Area: 48 IN x 96 IN
Mass: 1500 LBm

ENVIRONMENTAL LIMITATIONS: -90°F to +300°F.



SPIN TEST FACILITIES

Thiokol Chemical Corporation
Elkton Division
Elkton, Maryland 21921

DESCRIPTION: 37-IN Horizontal Spin Test Fixture

Powered by a 10 HP electric motor through a belt drive, this horizontal-firing fixture provides pressure, thrust, and spin rate measurements at rotational speeds up to 400 RPM.

DIRECTOR: D. H. Williamson; 301-398-3000 (Ext. 307)

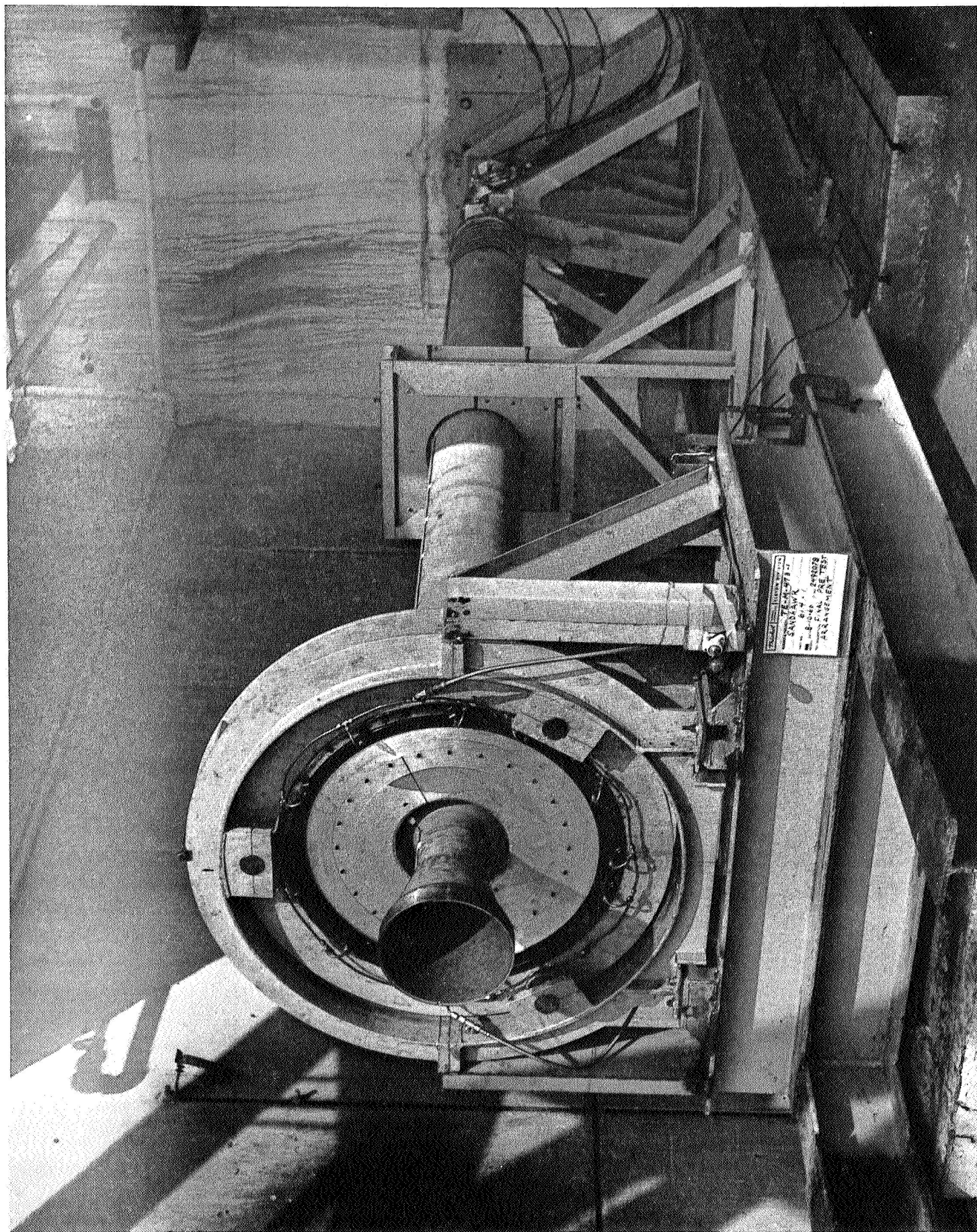
CAPABILITIES: Maximum spin rate: 400 RPM
Maximum motor diameter: 37 IN
Maximum motor length: 192 IN
Maximum motor mass: 4000 LBm
Maximum thrust: 30,000 LBf

DATA ACQUISITION: Pressure: 4 pressure transducers.
Thrust: 2 load cells.
Spin Rate: electromagnetic transducer.

DATA TRANSMISSION: 36-channel slip ring.

PHYSICAL CHARACTERISTICS: Height: 84 IN
Base Area: 54 IN x 120 IN
Mass: 4000 LBm

ENVIRONMENTAL LIMITATIONS: -30°F to +300°F.



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ARRANGEMENT

SPIN TEST FACILITIES

Thiokol Chemical Corporation
Elkton Division
Elkton, Maryland 21921

DESCRIPTION: Vertical Spin Test Fixture

Driven by a 2 HP electric motor, this vertical-firing spin test stand provides pressure and spin rate measurements at rotational speeds up to 1200 RPM.

DIRECTOR: D. H. Williamson; 301-398-3000 (Ext. 307)

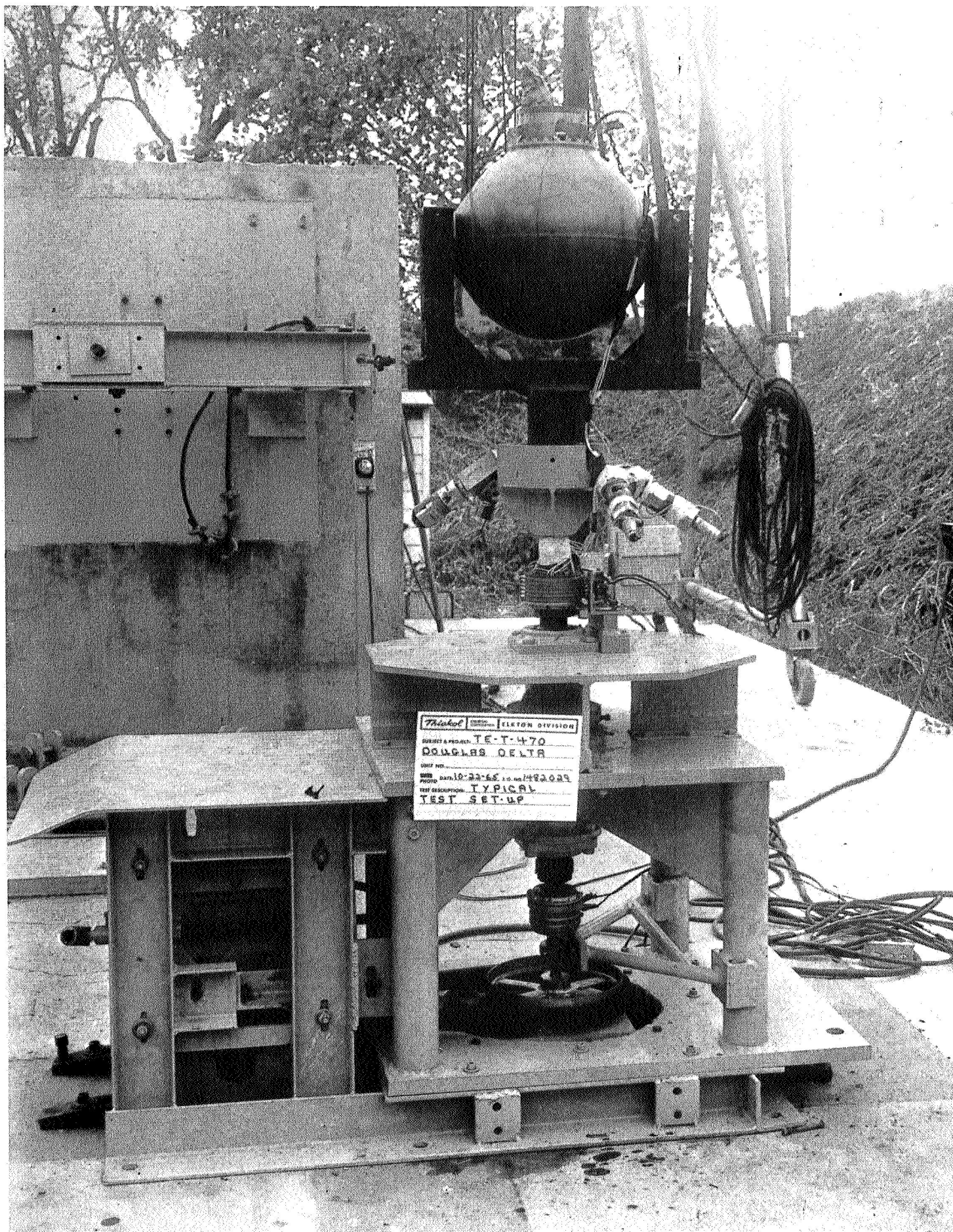
CAPABILITIES: Maximum spin rate: 1200 RPM
Maximum motor diameter: 15 IN
Maximum motor length: 18 IN
Maximum motor mass: 75 LBm
Maximum thrust: 10,000 LBf

DATA ACQUISITION: Pressure: 2 or 4 pressure transducers.
Thrust: None provided.
Spin Rate: Electromagnetic transducer.

DATA TRANSMISSION: 24-channel slip ring.

PHYSICAL CHARACTERISTICS: Height: 48 IN
Base Area: 36 IN x 48 IN
Mass: 450 LBm

ENVIRONMENTAL LIMITATIONS: Ambient to +300 F.



SPIN TEST FACILITIES

Thiokol Chemical Corporation
Huntsville Division
Redstone Arsenal
Huntsville, Alabama 85807

DESCRIPTION: Spin Test Fixture

Powered by a 5 HP DC motor through a belt drive, this horizontal-firing fixture provides thrust, spin rate, and pressure or head-closure temperature measurements at rotational speeds up to 16,000 RPM.

DIRECTOR: B. D. Herbert; Bldg. 7650; 205-876-9426

CAPABILITIES: Maximum spin rate: 16,000 RPM - (1)
Maximum motor diameter: 9.5 IN
Maximum motor length: 25 IN
Maximum motor mass: 150 LBm
Maximum thrust: 500 LBf

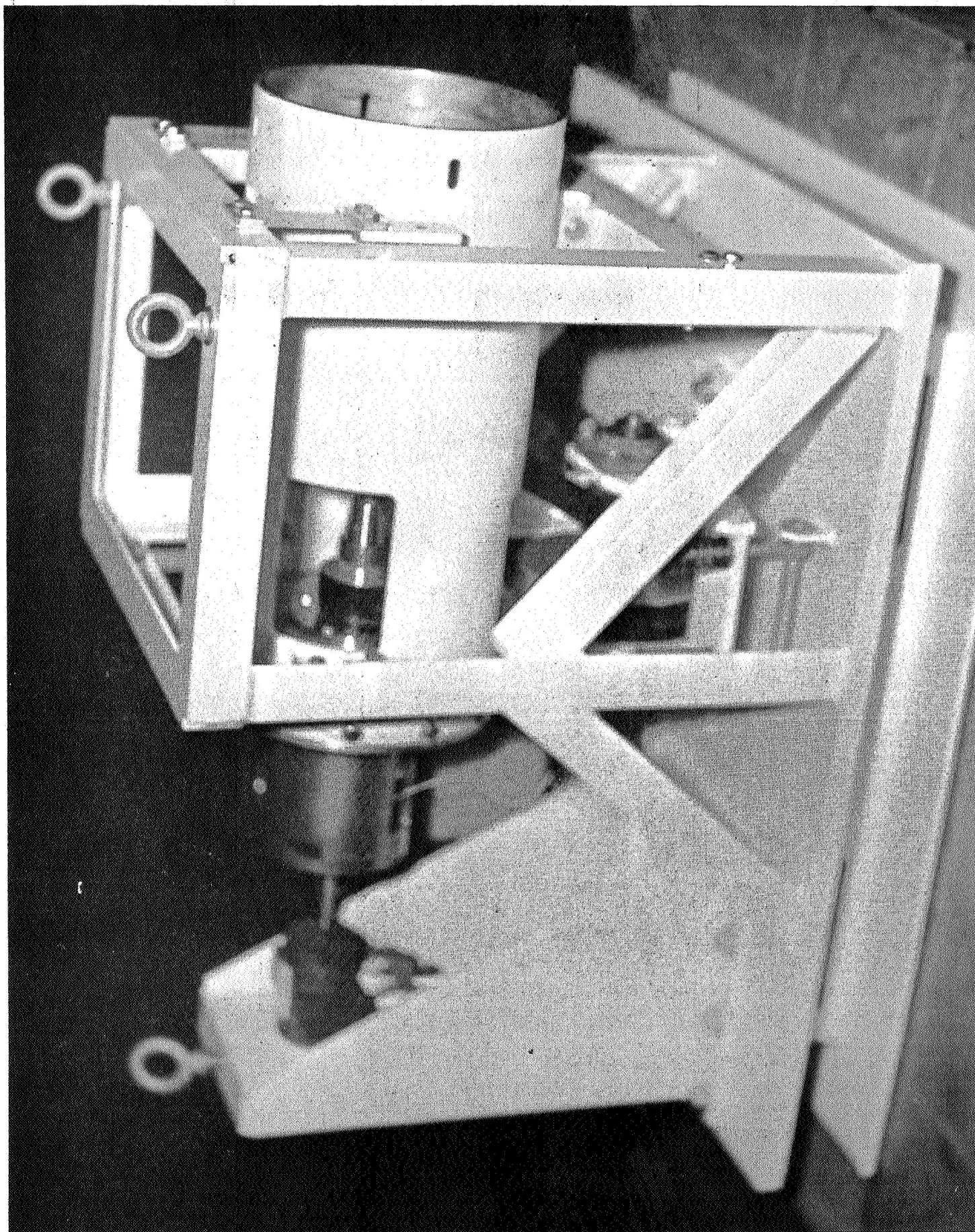
DATA ACQUISITION: Pressure: 2000 psi (CEC, Model 4-313-0001)
pressure transducer.
Thrust: 500 LBf (BLH, Model U1 #50016)
load cell.
Spin Rate: electromagnetic transducer built
into slip-ring assembly.

DATA TRANSMISSION: (Lebow, Model #6118-8) 8-channel slip ring.

PHYSICAL CHARACTERISTICS: Height: 30 IN
Base Area: 32 IN x 48 IN
Mass: 2000 LBm

ENVIRONMENTAL LIMITATIONS: -75°F to +170°F.

COMMENTS: (1) Spin rate limitations dependent upon selection of slip-ring assembly. Change in assembly will permit additional channels of data and/or higher spin rates.



SPIN TEST FACILITIES

United Technology Center
P.O. Box 358
Sunnyvale, California 94088

DESCRIPTION: Spin Test Stand

Powered by a 3 HP variable-speed electric motor through a belt drive, this vertical-firing fixture provides thrust, spin rate, and dual pressure measurements at rotational speeds up to 3500 RPM. - (1)

DIRECTOR: P. G. Willoughby; Bldg. 5200, RM. 265; 408-739-4880.

CAPABILITIES:

Maximum spin rate:	3500 RPM
Maximum motor diameter:	6 IN
Maximum motor length:	14 IN
Maximum motor mass:	4 LBm (Propellant)
Maximum thrust:	12,000 LBf

DATA ACQUISITION:

Pressure:	2500 psi (CEC, Model 4-326) strain-gage pressure transducers.
Thrust:	12,000 LBf (Kistler, Model 903) crystal load washer.
Spin Rate:	electromagnetic transducer.

PHYSICAL CHARACTERISTICS:

Height:	45 IN
Base Area:	32 IN x 43 IN
Mass:	600 LBm

COMMENTS: (1) This test fixture was fabricated under Contract NoW 66-0444C.

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SECTION III

CENTRIFUGE TEST FACILITIES

The capabilities of the twelve (12) centrifuge test facilities described herein are summarized in Table III-1. As indicated, full-scale motor testing capabilities are available at accelerations up to approximately 300 G's, depending upon the size, mass, and thrust produced by the test motor. In addition, two strand-burner centrifuges are available for use in: (1) obtaining burn rate/pressure measurements at the Naval Postgraduate School; and (2) observing the combustion process under acceleration at United Technology Center.

TABLE III-1: CENTRIFUGE TEST FACILITIES

ORGANIZATION	MAXIMUM ACCEL. (G's)	MAX. MOTOR DIAMETER (IN)	MAX. MOTOR LENGTH (IN)	MAX. MOTOR MASS (LB _m)
Boeing	500	16	20	300
Douglas	150	50 - 72	50 - 72	3000
Hercules (ABL)	55	30	168	6000
	100			100
NASA (LRC)	300	12	24	100
Naval P.S.	2000	(strands)	(5.0)	
NOTS (NWC)	225	5	84	200
Ogden Labs	300	6	36	200
	80	32	120	4000
Rohm & Haas	90	24	48	300
U.T.C.	700	(strands)		
Wyle Labs	200	7	18	200

CENTRIFUGE TEST FACILITIES

The Boeing Co.
Missile and Information Systems Division
Aerospace Group
P.O. Box 3996
Seattle, Washington 98124

DESCRIPTION: Gyrex 2133 Rotary Accelerator

Driven by a 30 HP electric motor through a manually controlled, variable-speed, eddy-current clutch, this facility is rated at 40,000 G-LB_f at a maximum acceleration of 500 G's.

DIRECTOR: B. V. Olson, Mail Stop 86-14; 206-773-4720.

CAPABILITIES: Maximum motor diameter: 16 IN
Maximum motor length: 20 IN
Maximum motor mass: 300 LB_m
Maximum acceleration: 500 G's

DATA ACQUISITION: Pressure: None
Thrust: None
Acceleration Level: Electromagnetic transducer
with (Hewlett-Packard,
Model 521DR) electronic
counter.

DATA TRANSMISSION: (Fabricast) 26-channel slip ring

PHYSICAL CHARACTERISTICS: Height: 72 IN
Base Area: 120 IN x 166 IN
Mass: 6000 LB_m
Radius: 52 IN

ENVIRONMENTAL LIMITATIONS: Ambient temperature.

COMMENTS: Test motors containing 1.0 LB_m of propellant have been tested on this fixture using opposing nozzles to cancel the thrust. Subsequent to this test series, the centrifuge required extensive refurbishment due to corrosion from the nozzle exhaust products.

CENTRIFUGE TEST FACILITIES

Douglas Aircraft Corporation
Missile and Space Systems Division
3000 Ocean Park Boulevard
Santa Monica, California 90406

DESCRIPTION: 36-FT Diameter Centrifuge Facility

This hydraulically driven centrifuge is rated at 150,000 G-LBf at a maximum rotational speed of 156 RPM.

DIRECTOR: J. Loef; Dept. A-270; 213-391-0311

CAPABILITIES: Maximum motor diameter: 50-72 IN - (1)
Maximum motor length: 50 -72 IN - (1)
Maximum motor mass: 3000 LBm - (2)
Maximum acceleration: 150 G's

DATA TRANSMISSION: 16 slip rings at 6 AMPS
149 slip rings at 2 AMPS

COMMENTS: (1) Motor size limitations dependent upon orientation.
(2) Maximum test specimen mass. Safety regulations limit amount of propellant mass. Maximum tested to date 27 LBm.

CENTRIFUGE TEST FACILITIES

Hercules, Inc.
Allegany Ballistics Laboratory
P.O. Box 210
Cumberland, Maryland 21502

DESCRIPTION: Diesel-Powered Ballistic Centrifuge

This 56 FT diameter centrifuge is driven by two hydraulic motors powered by a 500 BHP diesel engine through a variable-displacement pump.

DIRECTOR: R. S. Severyn; 304-726-4500

CAPABILITIES: Maximum motor diameter: 30 IN
Maximum motor length: 168 IN
Maximum motor mass: 6000 LBm
Maximum thrust: 100,000 LBf (0° to arm radius)
Maximum acceleration: 55 G's

DATA TRANSMISSION: 72-channel silver slip ring.

COMMENTS: Non-thrusting motors up to 122 IN in diameter, 108 IN long, and 20,000 LBm can be accommodated.

CENTRIFUGE TEST FACILITIES

Hercules Inc.
Allegany Ballistics Laboratory
P.O. Box 210
Cumberland, Maryland 21502

DESCRIPTION: "Snap" Centrifuge Facility

Using a hydraulically actuated "snap" mechanism, this fixture allows the acceleration load to be applied almost instantaneously to provide an optimum simulation of propellant viscoelastic response characteristics.

DIRECTOR: R. S. Severyn; 304-726-4500

CAPABILITIES: Maximum motor mass: 100 LBm
Maximum acceleration: 100 G's

CENTRIFUGE TEST FACILITIES

National Aeronautics and Space Administration
Langley Research Center
Langley Station
Hampton, Virginia 23365

DESCRIPTION: Variable Dynamic Force Vector Rocket Test Apparatus

This 16-FT diameter centrifuge test facility is rated at 66,000 G-LBf, and provides for simultaneous rotation of the test motor about its own axis at spin rates up to 3000 RPM.

DIRECTOR: G. B. Northam, Mail Stop 498; 703-722-7961

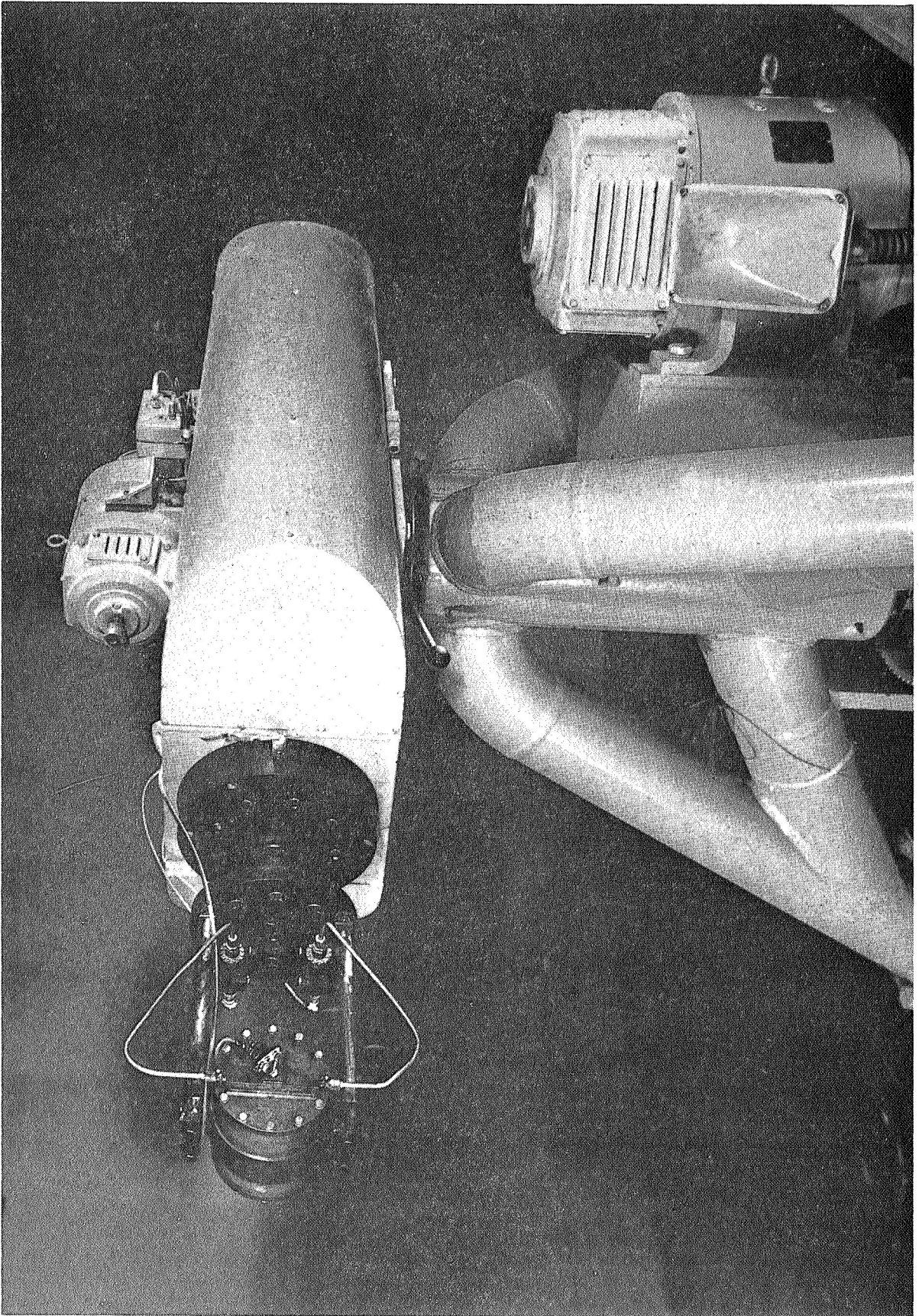
CAPABILITIES: Maximum motor diameter: 12 IN
Maximum motor length: 24 IN
Maximum motor mass: 100 LBm
Maximum acceleration: 300 G's

DATA ACQUISITION: Pressure: Dual (Dynesco, Taber, or Data-Sensor) strain-gage type pressure transducers.
Thrust: None provided.
Acceleration: Hewlett-Packard, Model 508) pulse-type tachometer with H-P, (Model 500B) electronic frequency meter.

DATA TRANSMISSION: (Occo-Manus Corp.-2030) 24-channel silver slip ring with silver-graphite brushes.

ENVIRONMENTAL LIMITATIONS: +40°F to +110°F.

COMMENTS: This test fixture is more fully described by M. H. Lucy, R. L. Swain, and J. L. Hudson, Jr. in: "Variable Dynamic Force Vector Rocket Test Apparatus"; presented at the Second Annual Meeting of the ICRPG Working Group on Static Testing; Redlands, Calif.; 21 October 1964.



CENTRIFUGE TEST FACILITIES

U. S. Naval Postgraduate School
Monterey, California 93940

DESCRIPTION: 76-IN Diameter Strand-Burner Centrifuge

Equipped with a 1665 IN³ strand burner/surge tank system, this facility is rated at 36,000 G-LBf at a maximum rotational speed of 1450 RPM.

DIRECTOR: R. E. Reichenbach; Code 57 RV; 408-646-2314

CAPABILITIES: Maximum acceleration: 2000 G's
Maximum strand length: 5.0 IN
Maximum operating pressure: 3000 psi

DATA ACQUISITION: Pressure: (Daystrom - Wiancko, Model P2-3086 or P2-1251) variable - reluctance pressure transducer.
Acceleration: (Space, Model PA-1) electro-magnetic transducer (RPM) and (Berkeley, Model 5545 EPUT) control.

DATA TRANSMISSION: (Lebow, Model 6109-12) 12-channel silver slip ring with silver-graphite brushes.

PHYSICAL CHARACTERISTICS: Height: 42 IN
Base Area: 48 IN x 48 IN
Mass: 1000 LBm

ENVIRONMENTAL LIMITATIONS: Ambient temperature.

COMMENTS: Driven by Chevrolet engine through Powerglide transmission.

CENTRIFUGE TEST FACILITIES

U. S. Naval Weapons Center
(Naval Ordnance Test Station)
China Lake, California 93555

DESCRIPTION: 15 FT Diameter Centrifuge

Currently under construction, this facility is scheduled for completion in 1968.

DIRECTOR: Roy B. Johanboeke; Code 4531; 714-357-1411
(Ext. 9321)

CAPABILITIES: Maximum motor diameter: 5 IN
Maximum motor length: 84 IN
Maximum motor mass: 200 LBm
Maximum acceleration: -225 G's with 28 LBm motor
-60 G's with 200 LBm motor

DATA ACQUISITION: Pressure: Not yet defined.
Thrust: Not yet defined.
Acceleration: Electro Products Lab., Model 3010 electromagnetic transducer with specially wound 'G' meter.

ENVIRONMENTAL LIMITATIONS: Ambient temperature:

CENTRIFUGE TEST FACILITIES

Ogden Technology Laboratories, Inc.
P.O. Box 181
Beaumont, California

DESCRIPTION: 60" Radius Arm Centrifuge - (1)

DIRECTOR: Gordon N. Adams; P.O. Box 181; 714-845-1103

CAPABILITIES: Maximum motor diameter: 6 IN
Maximum motor length: 36 IN
Maximum motor mass: 200 LBm
Maximum thrust: 1,000 LBf
Maximum acceleration: 300 G's

DATA ACQUISITION: Pressure: 10,000 PSI (Dynisco) pressure transducer.
Thrust: 2,000 LBf (BLH) load cells.
Acceleration: -(Statham) accelerometer.
-electromagnetic transducer.
-photoelectric transducer.

DATA TRANSMISSION: 48-channel silver slip ring, 0-500 RPM.
10-channel Mercury slip ring, 10-5000 RPM.

PHYSICAL CHARACTERISTICS: Height: 72 IN
Base Area: 72 IN x 72 IN
Mass: 80,000 LBm
Radius variable from 12 IN to 60 IN

ENVIRONMENTAL LIMITATIONS: -320°F to +400°F.

COMMENTS: (1) Maximum rating: 450 RPM with 200 LBm load at 55 IN radius.

CENTRIFUGE TEST FACILITIES

Ogden Technology Laboratories, Inc.
P.O. Box 181
Beaumont, California

DESCRIPTION: 144-IN Radius Arm Centrifuge

DIRECTOR: Gordon N. Adams; P.O. Box 181; 714-845-1103

CAPABILITIES: Maximum motor diameter: 32 IN
Maximum motor length: 120 IN
Maximum motor mass: 4,000 LBm
Maximum thrust: 45,000 LBf - (1)
Maximum acceleration: 80 G's

DATA ACQUISITION: Pressure: 10,000 PSI (Dynisco) pressure transducer.
Thrust: 50,000 LBf (BLH) load cell.
Acceleration: -(Statham) accelerometer.
-electromagnetic transducer.
-photoelectric transducer.

DATA TRANSMISSION: 48-channel silver slip ring 0-500 RPM.
10-channel mercury slip ring, 0-500 RPM.

PHYSICAL CHARACTERISTICS: Height: 72 IN
Base Area: 72 IN x 72 IN
Mass: 80,000 LBm
Radius variable from 12 IN to 144 IN

ENVIRONMENTAL LIMITATIONS: -320°F to +400°F.

COMMENTS: (1) Maximum thrust is dependent on total impulse.

CENTRIFUGE TEST FACILITIES

Rohm and Haas Company
Redstone Research Laboratories
Huntsville, Alabama 35807

DESCRIPTION: Genisco Model 1022-1 Centrifuge

This research facility was designed primarily for testing solid propellant structural integrity in a high-acceleration environment.

DIRECTOR: Dr. A. J. Ignatowski; 205-876-9930

CAPABILITIES: Maximum motor diameter: 24 IN
Maximum motor length: 48 IN
Maximum motor mass: 300 LBm - (1)
Maximum thrust: 200 LBf - (2)
Maximum acceleration: 90 G's

DATA ACQUISITION: Eight shielded instrumentation channels and power circuits are available on the test boom.

PHYSICAL CHARACTERISTICS: Height: 42 IN
Base Area: 21 FT diameter
Radius variable from 0 to 96 IN

ENVIRONMENTAL LIMITATIONS: Ambient temperature. - (3)

COMMENTS: (1) A maximum mass of 300 LBm may be attached to each end of the test boom, including test object, instrumentation, and mounting hardware.
(2) This facility is not designed for, and has not been used for, motor firings. However, firings of small motors could be accomplished.
(3) Test package may be heated or cooled as long as 300 LBm mass limit is not exceeded.

CENTRIFUGE TEST FACILITIES

United Technology Center
P.O. Box 358
Sunnyvale, California 94008

DESCRIPTION: Combustion Bomb Centrifuge

Powered by a 1.0 HP electric motor through a variable-speed hydraulic transmission, this facility produces an acceleration of almost 700 G's at the surface of a small propellant sample.

DIRECTOR: P. G. Willoughby; Bldg. 5200, Rm. 265; 408-739-4880.

COMMENTS: This centrifuge test facility, constructed under Contract N00017-67-C-2429 for the Naval Ordnance Systems Command, is to be used to photograph the surface of a burning propellant sample subjected to accelerations as high as 690 G's. An 8-channel slip ring transmits power to the photographic light source, the propellant igniter, and the purge gas system, and also provides for continuously monitoring combustion bomb pressure.

CENTRIFUGE TEST FACILITIES

Wyle Laboratories
P.O. Box 1008
Huntsville, Alabama

DESCRIPTION: 8 FT Diameter Centrifuge

DIRECTOR: W. W. Holbrook; 205-837-4411

CAPABILITIES: Maximum motor diameter: 7 IN
Maximum motor length: 18 IN
Maximum motor mass: 200 LB_m
Maximum acceleration: 200 G's, depending upon
weight and configuration

DATA ACQUISITION: Pressure, thrust, and acceleration level
measurements provided

DATA TRANSMISSION: - 2 pneumo/hydraulic swivels
- 15-channel slip ring

PHYSICAL CHARACTERISTICS: Height: 60 IN
Base Area: 48 IN x 48 IN
Mass: 4000 LB_m
Radius variable from -12 to 48 IN

COMMENTS: - This fixture is equipped with a pneumo/hydraulic system which: (1) allows the test motor to be moved from center position (0 G's), to a maximum radius of 48 IN, and back across the center to -12 IN, while (2) providing a simultaneous rotational capability.

- A number of additional Wyle centrifuges are also available, both at Huntsville, Ala., and at: 128 Maryland Street; El Segundo, California; 90245.